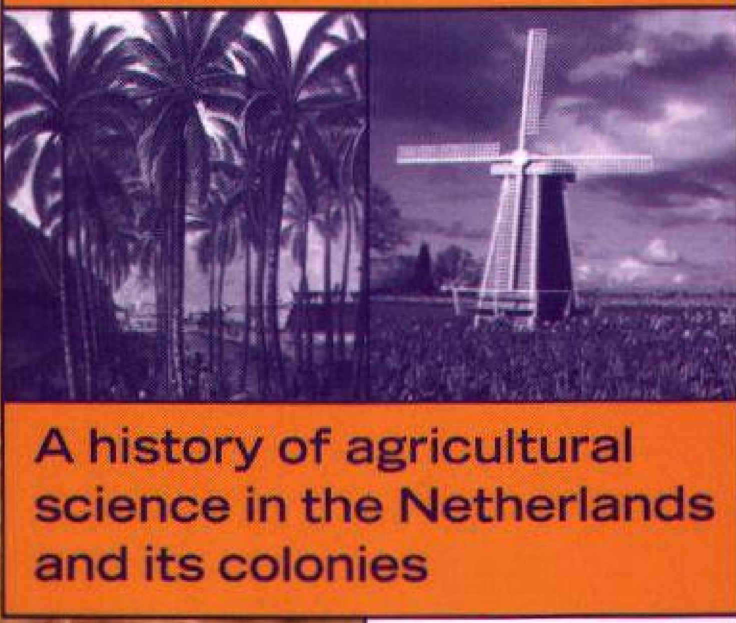
# Science cultivating practice



## A history of agricultural science in the Netherlands and its colonies

1863 | 1986

Harro Maat

# Stellingen

De voorlopers van Wageningen Universiteit (RHLTBS, Lh en LUW) hebben zich in hun organisatie en groei vooral georiënteerd op andere universiteiten en nauwelijks op ontwikkelingen in de landbouw in Nederland en andere gebieden.

Het positieve imago van de Wageningse instelling in het buitenland heeft ze vooral te danken aan haar koloniale verleden.

Aangezien veel afgestudeerden terechtkomen in (hoge) managementposities, kunnen universiteiten de omvang van het beleidskader verkleinen en de kwaliteit van onderzoek en onderwijs verhogen wanneer ze studenten via leerprojecten inschakelen bij hun eigen management.

Wanneer het falsificatieprincipe van de wetenschapsfilosoof Karl Popper wordt toegepast op het fenomeen stellingen bij proefschriften, moet worden geconcludeerd dat stellingen zonder bronverwijzing niet verifieerbaar en dus onwetenschappelijk zijn.

De basis van het vermaarde Nederlandse poldermodel ligt niet in de democratische gezindheid van de Nederlanders, maar in de angst te veel af te wijken van de ander. (Cf. Simon Schama, *The embarrassment of riches: an interpretation of Dutch culture in the Golden Age*.)

Aangezien de doorsnee wetenschappelijke instelling niet veel afwijkt van de doorsnee overheidsbureaucratie, zullen producenten en consumenten waarschijnlijk eerder een uitweg vinden in de huidige voedselcrisis dan de overheid of de wetenschap.

Aangezien Wageningen Universiteit een groot aantal proefschriften afneemt van haar promovendi, doet ze er goed aan over voldoende stellingen te beschikken.

# SCIENCE CULTIVATING PRACTICE

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1863-1986

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# SCIENCE CULTIVATING PRACTICE

## A history of agricultural science in the Netherlands and its colonies 1863-1986

Harro Maat

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# Acknowledgements

Working in an academic environment implies meeting many persons who, like myself, work on a thesis. Various colleagues who received a doctorate in the past years sent me an invitation for their defence and ensuing festivities. One of things I noticed at those events was that acknowledgements are a very well read part of theses. People chat about who the young doctor worked with, if the people mentioned are around at the party, if the persons not mentioned are left out deliberately or simply forgotten? The first time I joined in this type of conversation I was rather indifferent to the triviality of the conversation, but after a while I realised that this kind of social talk is an important element of science. As my supervisor once put it rather bluntly: "Scientists are more interested in gossip than in Nobel prizes." True or not, the point is that science is by and large a social process, and this notion has been central in the analysis leading to this thesis. The reason why I introduce the point here is to make clear to the reader, interested in the acknowledgements, that the rest of the book is also worth having a look at.

The persons most directly involved in the process leading to the book at hand were my supervisors, Paul Richards and Michiel Korthals. Paul is very good in short and powerful statements as quoted above, although the more elaborate comments on my ideas and drafts appeared most valuable. He often looked at things from an unexpected angle, which kept me sharp in observation and analysis. Michiel has been very supportive throughout the project. Because he is heading a group (Applied Philosophy) with a different focus and located in another building, the comments he made were generally inspiring and always refreshing. I joined various discussions and events of the Applied Philosophy group and the ideas and views of the people there appeared helpful in various ways. Specifically I need to mention Henk van den Belt, who already supported me when I was still an undergraduate. The Technology and Agrarian Development (TAO) group was my home base over the years. Being part of that group was (and is) an experience I will not likely forget. Two persons I have to thank in particular are Sietze Vellema, my "running mate" at TAO, and Dini Pieterse, who is a key person in maintaining order and overview in the practicalities of running a chair group.

Outside the Wageningen environment there are several persons that directly and indirectly contributed to my intellectual development over the years. The colleagues of the research school Science Technology and Modern Culture (WTMC) made me realise that the development of agricultural science can be connected to a range of broader issues and themes in Science and Technology Studies. Rob Hagendijk took a leading role in that process, not only by organising the many workshops, summer- and winter schools I attended but also by being an inspiring discussion partner. Another inspiring platform for discussion about my work and that of others was the so-called R&D group in Eindhoven. Ernst Homburg is the main shaker and mover behind this informal discussion group where researchers from different universities meet, sharing material and ideas in the history of science and technology in the Netherlands. Finally I want to thank all the people I interviewed, especially Hille Toxopeus who shared my interest in the history of colonial agriculture.

Besides all the intellectual input from people I encountered over the years, this thesis could not have been written without the support and assistance of computer system managers, canteen staff, librarians etc. Specifically I would like to thank Nico, chief of the *Nieuwlanden* building, the people from the central library *Jan-Kopshuis*, and Casper for all the energy put in the cover design and lay-out. Furthermore I am grateful to the organisations that allowed me to travel to various countries in order to find traces of Dutch agricultural science or to present some preliminary findings of my research. These are the *Nederlandse Organisatie voor Wetenschappelijk Onderzoek* (NWO), *Stichting 'Fonds Landbouw Export-Bureau 1916/1918'* and the Society for the History of Technology (SHOT). I also want to thank Johan Schot for all his efforts to make sure that there is more work after finishing a thesis.

A very special category of people supportive over the years covers family and friends. In the first three year of the project I lived in three different places, sharing the housekeeping with various other persons. Several of them turned into good friends and I would like to thank them all for all the fun, including the quarrels over who's turn it is doing the dishes or feeding the cat. Two friends I want to thank in particular. In the many hours spent with Aart I learned that the quality of life can increase significantly when you pay more attention to what you eat and drink. Peter appeared indispensable because he always took the time to discuss obstacles and challenges in doing research, but basically we talked about whatever other issue that came up. Thank you guys!

This thesis was finished in the year 2000. Nevertheless, I will never forget that year for an entirely different reason. When the book reached its completion my greatest supporter Yolande gave birth to our son Sander. Compared to that experience, finishing the thesis will only be stored as a footnote in my memory.

# Contents

# 1

# Introduction

## Scope of the thesis

"People are apparently not aware that: 1) more knowledge and broad education lead to more prosperity for the farmer as for anyone else; 2) the future farming community should no longer be withheld from the development that is part of those who are educated in other scientific professions."[1]

"What is alarming is that knowledge is apparently not relevant. The public opinion is powerful and becomes an autonomous phenomenon, strengthened by colleagues from other media. (...) Well then, participation in the public debate means that people from Wageningen University and research institutes have to express forcefully their opinion and add facts to the peculiar blend that now forms the public opinion."[2]

These two quotations contain in all their brevity most elements that are central in this thesis. In both excerpts worry and dissatisfaction is expressed about the impact of education and knowledge. The second phrase is very clear about the origin of this knowledge, Wageningen University and research institutes, located in a town in the central region of the Netherlands. The first quote seems to refer to education in general but in fact hints at the same organisation of education and research, although in a different time and with another name. Moreover, the phrases address a certain audience. Both contain general denominators like "people" and "public opinion". Only in the first quotation the expressed worry over the impact of knowledge is connected more specifically to the farming community. This difference relates to a change in task and in the social environment that the education and research are aimed at, reflecting distinct periods of time. The first quote is from the early 1880s and in this period the institute in question was a small school offering scientific knowledge to the farming community. The second quote was written in the late 1990s, a period in which the education and research facilities have become an institution rather than an institute, covering issues and topics of a much wider scope than agriculture alone. This change and growth in agricultural research and education is the major development followed in this book. Scientific education and research for agriculture in the Netherlands and its colonies has always had a direct or indirect organisational connection with the Wageningen institution. Late 1990s the institution changed its name in Wageningen University and Research Centre and in that name agriculture is no longer visible, reflecting several changes in the organisation and in society in general. From 1986 until the late 1990s the name of the institution was Agricultural

[1] *Programma van het onderwijs* (1880), 59.

[2] Vink, "Een maatschappelijk debat", 10-11.

University (*Landbouwuniversiteit)* resulting from a change in the Higher Education Act. From 1986 back to 1918 it was an Agricultural College (*Landbouwhogeschool)* and 1918 was the year of integration in the higher education act. Before that period it was an agricultural school. The school was a product of an education act of 1863 but opened its doors not before 1876 under the name State Agricultural School, *Rijkslandbouwschool.* The overall objective of the entire period from 1863 until 1986 was to improve agriculture in the Netherlands and its colonies. That objective was pursued in the nineteenth century by offering scientific education to young people aspiring to become well-educated farmers. The worry in the first quote refers to the fact that the school only attracted a small number of students, many of them not stemming from a farming family. Early twentieth century the direct transfer of (scientific) knowledge to the farming community was left to other services and schools. The agricultural school, -college, and -university, concentrated on research and experimentation on the one hand and the education of researchers and practitioners for public and private agricultural institutes and services on the other. In analysing this development in Dutch agricultural science, my attention was focused on some specific features. The context of the two opening quotes reveals what this is about.

As explained, the first quotation points at the importance of scientific education for the farming community late nineteenth century. The second quote relates to a highly disputed issue of the late 1990s, modification of the genetic make-up of plants and animals. Furthermore, the phrase refers to a public debate and a public opinion, a much broader audience than only the farming community. This change in the kind of education and research offered, as well as the change in the audience and field scientific knowledge is developed for, is here interpreted as changes in the relation between science and practice. Science and practice are conceived as broad categories. In the rest of this book science refers to a range of activities of various people with academic degrees, activities resulting in knowledge, and technologies applied to a certain practice. Practice is understood in an equally broad manner and can relate to one or more farms, the crop on a farmer's field, a computer model or experimental setting, processing and consumption of food, various activities in a rural setting and so on. Because agricultural science is the main subject of this thesis, living organisms, including human beings, play an important role in such practices. Moreover, as the thesis covers the Netherlands as well as its former colonies, these practices can be located at various places in the world. This broad interpretation of science and practice also implies that a clear distinction between the two categories is not always easy to make. Where science ends and practice begins is not a direct analytical target of this thesis, but conceived as (varying) manifestations and expressions in the organisation, activities and expressions of agricultural scientists. The change in the relation between science and practice over the years is visible in the opening quotations in another way too.

The first citation stems from a series containing the programme of education of the State Agricultural School and the report over the previous school year. The author is the director of the school in those days, C.J.M. Jongkindt Coninck. The second quote is from the independent weekly newspaper of Wageningen University and was written by its general editor, S. Vink. A few months after he expressed this view he was appointed as head of the public relations office of the university. The agricultural school of the nineteenth century with about a hundred students, and a director that performed most of the administrative and representative tasks himself, developed into a small but modern university with about four thousand students, a vast administration system, a university newspaper and a public relations office. This makes clear that the connection between theory and practice in the nineteenth century not only concerned different issues than in the late twentieth century, but that this connection is also embedded in very different forms of organisation in different periods of time.

In sum, this thesis tries to answer two questions. How did agricultural science develop in the Netherlands and its colonies between the 1860s and 1980s? What were the consequences of this development for the connection between science and practice?

**Background of the study**

The analysis presented here is grounded in and will hopefully contribute to insights in two fields of study. The first is generally known as Science and Technology Studies. Science and Technology Studies has roots in several branches of the social sciences, including philosophy and generally questions what the social configuration of scientific practices is, and how scientific knowledge production and technology development are linked up with other activities in society.[3] The issues and subject covered by Science and Technology Studies are broad and varied. A common finding is that scientific knowledge and technological artefacts are not natural phenomena or processes discovered or put to work by scientists and engineers but are primarily the result of interactions between scientists, technologists and other persons. In other words, science and technology are social constructions. This conclusion is also a guiding principle for many studies in the second scientific field this thesis links up with, the history of technology.[4] The history of technology is a field of study with a rather strong focus on engineering but also covers other technological domains, including agriculture.

The guiding principle of both fields - science and technology as social constructions - implies that an analysis of a scientific discipline, research institute, artefact or technological system homes in on the human activities, organisation and social structures in combination with the phenomena, materials and organisms the

[3] Bijker and Law, *Shaping technology - building society*. Jasanoff, Markle, Petersen and Pinch, *Handbook of science and technology studies*.

[4] Lintsen en Homburg, "Techniekgeschiedenis in Nederland."

scientists and engineers under study work with. A consequence of this approach is that science and technology are not considered as closed fields, fenced off from other activities in society but are part and parcel of society, in many ways linked with other social domains. Such perception of science and technology is highly supportive to an analysis of agricultural science with an emphasis on the relation between science and practice. The shared principle between the history of technology and Science and Technology Studies does not mean that the two fields are almost identical. A rather obvious difference is that the first field of study primarily concentrates on historical cases where the latter discipline mainly looks at recent developments and examples in science and technology. A more principle difference relates to the theoretical interests of the two fields. Despite the overlap it can be said that in Science and Technology Studies theoretical concerns concentrate on the nature of the social structures underlying science and technology.[5] In the history of technology most theoretical attention is paid to the nature of processes of change and continuity that characterise developments in a certain time span.[6] These are general characterisations covering various notions and debates but it is not the direct aim of this thesis to expand or challenge the various theoretical notions in either of the fields. The overall aim of this thesis is primarily to make an empirical contribution to both fields. Nevertheless, theory cannot be avoided and in the following paragraphs I will sketch the major theoretical notions considered helpful in the historical analysis of agricultural science in the Netherlands and its colonies.

## Inspiring theoretical notions

Agricultural science in the Netherlands is not easily reduced to a well-demarcated set of activities in Dutch society. Especially when the former colonies of the Netherlands are included in the story, geographical distance and all the differences in climate and natural conditions make the development of Dutch agricultural science a broad and complex issue that is difficult to pin down. The comprehensive nature of agricultural science is further complicated by the fact that scientific activities for agriculture are performed in the context of various institutes, growing in number over the years. This observation, however, is informed by a specific interpretation. Perceiving agricultural science as a set of activities performed by human beings qualified for the job and the organisation of these activities makes clear that the approach that is taken in this study is sociological. A sociological interpretation of the development of agricultural science in the

[5] Hagendijk, *Wetenschap, Constructivisme en Cultuur.*

[6] Basalla, *The evolution of technology*.

Netherlands and its colonies over roughly the past hundred and fifty years provides various possibilities to structure analysis. From different fields in the social sciences some interesting notions are taken up.

**Professional hierarchies**

Putting an analysis of agricultural science in a time frame raises questions about the beginning and the end of the period or, more substantially, the origin of agricultural science in the Netherlands. From the perspective taken this results in the question "at what moment in the past can a set of activities be identified with a clear connection to agriculture but discriminated from other farming activities, and having such characteristics and organisational form that the designation 'agricultural science' is legitimate?" Chapter two contains most of the historical elements for an answer to that question, but an answer can also be derived with the help of a particular type of sociological studies.

The history of the institution for agricultural sdence in the Netherlands is very similar to an institution nowadays called Technical University Delft. Both institutions originate in the nineteenth century, starting as schools providing scientific education but not included in the system of higher education. A change in the Higher Education Act in the early 1900s freed the way for both schools to acquire academic status, although they were not given the name university, but *hogeschool*, a name that refers to the higher education system and is translated through this story as 'college'. The graduates from the Technical College in Delft received the title engineer (*ingenieur*) abbreviated in Dutch as *ir*. The graduates of the Agricultural College in Wageningen received the same title, resulting in a situation that an agricultural engineer from the Netherlands (*andbouwkundig ingenieur*) indicates an agronomist with various specializations instead of the general (Anglophone) meaning of a person fiddling with farm machinery. Based on these facts it is a logical step to look at similarities between the historical background of the agricultural engineer and the technical engineer in the Netherlands.

The origin and development of the technical engineer in the Netherlands is well documented by Harry Lintsen and Nil Disco.[7] By and large, their findings match with histories of technical engineers in two countries most influential on the Netherlands in late eighteenth and nineteenth century, namely France and Germany.[8] The general pattern that arises from these studies is that towards the end of the eighteenth century certain higher-ranking persons in industry and the military associated themselves with scientific - mainly mathematical - education. An interesting finding is that the technical practitioners did not group around

[7] Lintsen, *Ingenieurs in Nederland*. Disco, *Made in Delft*.

[8] Weiss, *The making of technological man*. Lundgreen, "Engineering education."

science primarily out of economic or technical necessity, but mainly to distinguish themselves from other practitioners in the professional field.[9] In other words, science was an important means to create and confirm rank and status. In late eighteenth century France and Germany this can be traced among technicians in public as well as private service. In the Netherlands this process was confined to the military, where scientific training was an important element for technical officers, distinguishing them from other officers and lower ranking technicians in the army.[10]

European agriculture at the turn of the eighteenth and nineteenth century was lacking a development similar to the developments in the industrial and military technical fields. There were several initiatives of so-called "gentlemen-farmers" from various countries to develop and apply scientific methods to agriculture and several academics put their knowledge at disposal of agriculture.[11] Moreover, in the first half of the nineteenth century a number of provincial agricultural societies were established with the aim to improve regional agriculture. Leading figures in these societies were mostly local notables, wealthy farmers and university professors. In short, two crucial conditions, elite group formation and affiliation with science, were present in agriculture in the Netherlands of the late eighteenth and early nineteenth century but did not result in the formation of a separate social category of "scientifically trained agricultural expert". The agricultural engineer in its Dutch connotation originated in the second half of the nineteenth century, and is primarily a result of shaping forces that also affected industrial and civil equivalents in that period, the expansion and restructuring of the national education system.[12] Although earlier developments and other factors played an important part, the main incentive came from the Dutch government.

Academic analysis of group formation based on scientific education and expertise is known as professionalization studies.[13] For the Netherlands this approach is not only applied to the field of technical engineering but also to other fields such as the emergence of economics as a scientific profession.[14] The main aim of these studies is to find out how and why a professional group managed to distinguish itself from professional competitors and maintain a privileged position regarding the solution of problems in a certain field of practice. In the cases of the technical engineers and economic experts in the Netherlands the role of the state is crucial. Experts make use of the bureaucratic and financial facilities of the government to support and protect their position as professional experts. The role

[9] Weiss, *The making of technological man*, 13-25.

[10] Lintsen, *Ingenieurs in Nederland*, 25-34. Disco, *Made in Delft*, 43-52.

[11] Van der Poel, *Heren en boeren.*

[12] Lundgreen, "Engineering education", 56-75.

[13] Disco, *Made in Delft*, 7-42. Abbott, *The system of professions*.

[14] Wilts, *Economie als maatschappijwetenschap*, 7-10.

of the state, and the competition among experts, are characteristics that apply very well to developments in agricultural science, especially in the Dutch East Indies of the early twentieth century. In the colonial context, agricultural science was from the early nineteenth century the domain of university biologists. In the early twentieth century the colonial government expanded its research facilities, and university biologists considered this as an opportunity to expand their range of activities. Nevertheless, the establishment of new government services cleared the way for graduates from the Agricultural College in Wageningen to invade the public and private colonial research institutes. The university biologists considered the arrival of Wageningen agronomists as a serious threat to their position in the agricultural scientific institutes, resulting in fierce discussion, both about professional competence and the true nature of agricultural science.

Based on this example the sociology of professions seems to provide highly appropriate insights to analyse the development of agricultural science in the Netherlands and its colonies. Competition among different types of professionals and exploitation of government facilities to establish and maintain an expert position are phenomena that are certainly present in the agricultural sciences. Although these insights are taken on board in this study, there are some elements in the development of agricultural science that are more difficult to explain from this perspective. Besides the already mentioned lack of an early professionalization phase in agriculture similar to the technical engineering professions, later events in the Dutch East Indies reveal a coexistence of experts with various backgrounds, holding similar positions. In other words, emphasis on distinctive expertise and competition among different professionals were not always fought out to the bitter end. Moreover, the role of the Dutch government in the creation and further development of agricultural science goes further then providing opportunities for agricultural engineers to sustain their professional expertise and territory.

## Agricultural science and agrarian policy

Understanding of the development of agricultural science in the Netherlands is unthinkable without taking the role of the national government into consideration. As explained in the previous section the origin of agricultural science and the Dutch agricultural engineer in the second half of the nineteenth century is by and large a result of the expansion and restructuring of the national education system, a pre-eminent state activity. Government policy and state regulation lay at the basis of agricultural science and continued to influence concrete processes and general aims in its development. For example, the large majority of agricultural research and education activities is financed, directly or indirectly, with public money. A financial linkage is a rather straightforward example of dependency, but does not immediately touch the point that such dependencies are articulated in the concrete activities of agricultural scientists and the representation and justification of these activities. The articulation of linkages between government policy and scientific research is the central focus in studies looking at the interaction between social policies and social sciences in different countries.[15] This interaction is not only apparent in various countries but is also a historical phenomenon.

The central argument of these studies, mainly developed by Peter Wagner, is that the sort of knowledge produced in the social sciences is a result of an interplay between specific national intellectual traditions and the impact of political structures and social policies of governments.[16] Especially in the 1960s and 1970s this interplay resulted in a strong affiliation between social science and public administration resulting in what he terms a "discourse coalition".[17] In a discourse coalition social phenomena are commonly defined through interaction between social scientists and government administrators. A discourse coalition favours mutual understanding of social problems, makes it researchable for scientists and manageable for administrators. Moreover, a discourse coalition sustains both the authority of governments and the status of social science disciplines. In weaker forms of interaction between governments and social science disciplines, the sharing of perception and approach regarding certain social issues is less, and parties can be critical or even opposed to one another.

Regarding Dutch agricultural science a direct parallel can be traced in the emergence of agrarian sociology at the Agricultural College in the 1950s, showing many characteristics of a discourse coalition. The early Wageningen sociologists investigated how the farming community could be prepared for the modernisation of agriculture, the main goal of the Ministry of Agriculture in those days.[18] The emergence of Dutch agrarian sociology however has a more complicated history, outside immediate scope of this thesis. Moreover, examples of lacking congruence between policy development and scientific approach in agriculture can also be found. In 1905 the colonial government of the Dutch East Indies created a Department of Agriculture in order to increase its control over food production. The main creative force, and first director of this department, was the biologist Melchior Treub. In his view the scientific facilities for colonial agriculture should be strictly separated from the administrative tasks of the department, and researchers should be entirely free in their study. Treub's perception resulted in some serious clashes with the colonial administration and when he resigned for health reasons he was replaced by the former government director of agriculture in the Netherlands, Herman Lovink, who favoured a closer integration of scientific facilities and agrarian policy.

[15] Wagner and Wittrock, "States, institutions, and discourses." Wagner, "Social science and the state in continental Western Europe."

[16] Wagner, "Social science and the state in continental Western Europe", 510.

[17] Ibid., 521-522

[18] Gastelaars, *Een geregeld leven*, 185-232.

Studies in the history of the social sciences and of the connection to social policy formation in various countries tend to show that the interaction between social sciences and policy making tends to be close and that overall patterns are similar in different countries. The main lesson to be drawn from these studies is that the interaction between policy-making government administrations and knowledge-producing science institutes is a regular occurrence but varies in intensity. Further, for each particular country and time period the interaction articulates differently in the domain of social research and the domain of policy making, depending on the degree of mutuality of perspective.[19] If shared interest leads to great affinity (a discourse coalition), the result is a commonality in ideas, viewpoints and judgements regarding the sorts of problems to be dealt with and the type of solutions to work at. When affinity flags, or when coalition formation is dispersed over different interest groups, views and strategies concerning problems and solutions will differ and be more conflicting. The notion of shared interests and ideas between government administrations engaged with agriculture and the agricultural sciences will probably fit the development of agricultural science over the entire period studied. From its origin late nineteenth century until the 1980s the policy agenda of the Dutch government and the issues researched by the various disciplines of the agricultural sciences show much similarity. However, in this thesis this route is not followed all the way, for several reasons.

First of all, this thesis only follows the scientific part of the story. A true implementation of the methodology applied in the studies of interaction between social policy and social science would require a balanced analysis of knowledge producing institutions and the institutional arrangements in politics and administration.[20] In this thesis government policies, legislation and state regulation frequently appear as important shaping forces in the development of agricultural science but the processes leading to policies and regulation for the agricultural sector, and how that interacts with agricultural science, is not an explicit focus. Secondly, it is doubtful whether the development of the social sciences, even in an abstract analytical sense, covers all the features of the development of agricultural science. It is clear that there is a large overlap regarding the interaction with government policies. Even so, agriculture is first of all a social activity and to some extent agricultural science can be conceived as a social science. Nevertheless, agricultural science is a broad category that not only covers human activity but also the behaviour of and processes in plants, animals, soils, fungi, water and the like. Finally, the co-evolution of social sciences and modern states is in the studies referred to primarily explained as a historical process. Although this thesis follows a not dissimilar route, and throughout supports this kind of explanation, some other notions are taken up to shed further light on the specific nature of the

[19] Wittrock, "Social knowledge and public policy."

[20] Wittrock, Wagner and Wollmann, "Social science and the modern state", 71-75.

supposed intimacy between policy makers and scientists devoting their time to the agrarian sector. In short, some more needs to be said about the role of non-human elements and, to start with, the background of shared (or conflicting) perspectives and ideas.

## Institutional thinking

A particular feature in the development of the social sciences in the Netherlands in relation to government social policies is a concern for specific interest groups in the policy and science arena.[21] This observation matches very well with findings in a case study of the social organisation of the Ministry of Agriculture in the Netherlands, performed by Jouke de Vries.[22] In the ministry the cooperation with non-governmental agencies was crucial in policy formation and De Vries' characterisation of the practice of defining and implementing agrarian policy within the Ministry of Agriculture shares many features with the discourse coalition explanation. The intention of De Vries, however, is not to show the co-evolution of the agrarian policy of the ministry and the agricultural sciences. The case describes how the organisation of the Dutch Ministry of Agriculture underpinned a perception and way of dealing with issues that conflicted with the vision and behaviour of the Department of Natural Resources, whose staff were transferred from another ministry to the Ministry of Agriculture. De Vries explains this conflict as a culture clash between two different types of social solidarities.[23] This explanation is based on a theoretical approach in the social sciences known as (neo-Durkheimian) Cultural Theory.

Cultural Theory provides an answer to the fundamental sociological question how social order is constituted. According to the theory there are four basic formations of social order to which in principle any social collective can be reduced.[24] The four different forms of social solidarity or institutions entail different moralities, and ways of perceiving and assessing risks. In short, social solidarity shapes cognition, which is why the four different social solidarities are also labelled as thought styles.[25] The four types are derived from a combination of two basic forces that sustain sociality, the measure of regulation (grid) and the measure of social involvement (group). These dimensions can be either strong or weak and in combination this results in four types denominated as individualism (low grid, low group), hierarchy (high grid, high group), egalitarianism (low grid,

[21] Blume, Hagendijk and Prins, "Political culture and the policy orientation in Dutch social science."

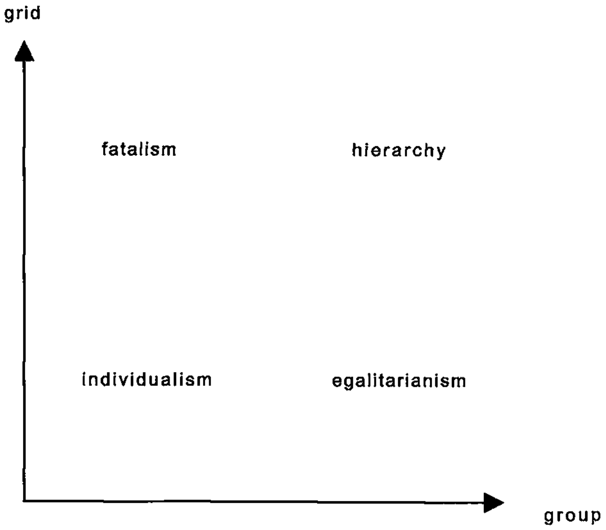
[22] De Vries, "A Trojan horse in the Dutch Ministry of Agriculture."

[23] Ibid., 97.

[24] Thompson, Ellis and Wildavsky, *Cultural theory.* Thompson, Grendstad and Selle, *Cultural Theory as political science*, 1-23.

[25] Douglas, *Thought Styles*, 77-105.

**Figure 1: Basic forms of social formation according to Cultural Theory**




high group) and fatalism (high grid, low group). Because each of the four social formations is a result of the same combined dynamism, they hardly come separately and often all four forms can be distinguished in different situations. The wide range of issues studied by using Cultural Theory makes clear that the type of social phenomenon analysed does not really matter, although the different forms take shape most prominently when conflicts arise.[26] Regarding agricultural science one specific element in Cultural Theory studies is very informative - the perception (or myths) of nature according to the four basic solidarities. This work reflects a strong focus in Cultural Theory on public concern over environmental risks and environmental policies.[27] Because agriculture can be considered as a form of fiddling with nature, the myths of nature are informative for an analysis of agricultural science. In a hierarchical solidarity nature is considered as resilient within certain limits. Such limits can be determined with the help of scientific research that consequently forms the basis of a proper policy regarding nature and agriculture. According to the solidarity of individualism nature has an unlimited resilience. Regulation and restrictions in the exploitation of nature are therefore not necessary and even unwanted for a maximum benefit from natural resources. Scientific research in this perspective should focus primarily on ways of exploiting nature as efficiently as possible. In the egalitarian solidarity nature is considered fragile and any disturbance of the delicate balance of ecosystems will have

[26] Thompson, Grendstad and Selle, *Cultural theory as political science*, 5-6.

[27] Ibid., 6-7. Thompson, Ellis and Wildavsky, *Cultural theory*, 25-38.

disastrous effects. Research should be restricted to distant observation with a preservative aim. And finally in the fatalist solidarity nature is considered unpredictable and research will not help very much in trying to overcome that. Translating these styles of thought as applied to nature, and the role of research, to the field of agriculture will most likely result in a picture resembling that painted in the study of Jouke de Vries on the Ministry of Agriculture discussed above. Affiliation between the ministry and agricultural science as discussed in the previous section suggests that hierarchy and individualism will be the major forms of social solidarity in agricultural science. The corresponding perceptions of nature also give relatively much room for science to experiment with soils, plants and animals. However, these observations are not linked to hypotheses proposed in this thesis. Cultural Theory is discussed here only to remind us that behind description of an evolving relationship between agricultural science and its paymasters lie some wider issues of institutionalisation, culture and style of thought. Besides, the point of the theory is not to categorise a scientist or any other person in one of the four social formations, but to explain why conflicting views take on a moral as well as technical tone.

The crucial insight of Cultural Theory taken on board in my analysis of agricultural science is to distinguish organisational formations as the social and cultural context of individuals. The four types of solidarity refer to a social collective, and the thought style of a collective is an effect of social interaction and not the aggregate of a series of individual minds. In other words, people can perceive things or make decisions that are first of all a result of the social relations they are involved in. This is what Mary Douglas called institutional thinking.[28] In the history of Dutch agricultural science as presented here, much attention is paid to the social context in which agricultural scientists work. The insight that these social contexts or institutions sustain (at least part of) the thinking helps to explain why particular research or a certain solution for a problem is favoured above others, and tends to recur. Moreover, the notion of institutional thinking implies that the extent to which social contexts are reproduced or changed determines the range of options being thought about for solving new problems and the direction that is perceived fruitful for new research tracks. In other words, Cultural Theory provides insight in the causes of historical continuity and change, as well as pushing forward a challenging notion - if you want to change the scientific output then maybe it helps to change the way units of academic researchers and teachers are organised and administered.

[28] Douglas, *How institutions think.* Fardon, *Mary Douglas*, 225-240.

**Defining boundaries**

It is very easy for most human beings to recognise other human beings, although especially kids can become confused when they meet an actor dressed like a robot or wearing a monkey suit. Things can become much more confusing considering abstract elements of human behaviour or human cognition. An interesting example comes from a study by Perri 6 on developments in autonomous intelligent systems.[29] He describes how a number of robots, each with freedom of movement and the ability to exchange information, develop inductively systems of communication that can become incomprehensible for the creators of these robots when the development is not followed closely at every stage. These shared systems of communication refer to various sorts of objects (movable and non-movable) these robots have to deal with and the different responses to these objects the robots are programmed with. By interacting with each other these robots developed a system of classification. An interesting element of the experiment is that in each session the robots were put together different classifications emerged, explaining why the communication system became so complex. In terms of the issues discussed in the previous paragraph, these robots developed a primitive form of an institution, allowing them to move around smoothly in the experimental setting. This example brings together some interesting elements and connects to some of the things discussed before.

Straight off from the introductory example comes the point that the difference between what humans are and are able to do, and what non-human objects are and what they can do, is less clear-cut when given a closer look. In the example described it is about how the intelligence and learning capacity of robots is very similar to human intelligence. Robotics is a specific branch of modern technology and there are many examples from other technologies that copy or relieve human activity. The interaction between human activity and performance of technological artefacts or other living organisms is also a crucial focus point in the field of Science and Technology Studies. The argument that science and technology are inextricably bound up with modern society implies that in order to understand the complexity and development of the 'techno-society' equal attention must be paid to people and non-human objects and organisms, and the way human and non-human institutions develop. The importance of non-human objects in the development of agricultural science and agro-technologies is a case in point. An interesting example from the interview material gathered for this thesis is a story of a rice breeder who never got his doctorate. After two years of studying the inheritance of certain physiological features of rice plants in Surinam, in the early 1960s, he was allowed by the company where he worked to return to Wageningen for a year to compile a thesis. Processing his material with a statistician, they gradually discovered an awkward problem. The data gathered in two years were

[29] 6, *Morals for robots and cyborgs*, 28-29.

from four generations of a rice variety, as the climate allows for two crop cycles a year. The coastal region of Surinam, where the experiments were conducted, is about six degrees north of the equator. The difference in day-length between the winter and summer period is hardly noticeable for people, but the studied rice plants appeared to notice very well and grew differently over the seasons, resulting in a rather big statistical disturbance of the studied features. A solution for the rice breeder would have been to continue the experiments for another two years or reconfigure the experiment in such way that his figures would be useful for a different analysis. Both options would have taken much more time to construct a thesis, time the employer did not grant. The rice breeder was so disappointed that he never took up the initiative for a thesis again and continued his career without a doctorate. This example shows various things. First of all, plants and other living creatures can respond differently even when circumstances vary only slightly. This requires a careful interpretation by the scientists working with such material, but equally so by the researcher studying these scientists and the material they work with. Secondly, in working out the data of the field experiments the studied rice plants changed into a series of numbers and qualifications that have a rather different meaning for the breeder and the statistician than the rice plants had in Surinam. This 'translated' rice is what in the end becomes the crucial object for the researchers and in the example determined the further career of the breeder. This process of interpretation and translation of data is a common feature of science, revealed by Science and Technology Studies.[30] The relevance of this point for my thesis is that the relation between (agricultural) science and practice can take shape differently in different social settings and environmental circumstances, even when agricultural scientists refer to the same objects.

A second point that can be derived from the example of the interacting robots concerns the observation that they developed a system of classification. The classification system allowed the robots to determine what movable objects are (and thus can be put aside) and what non-moveable objects are (that should be avoided). The importance of classification systems is taken up in Science and Technology Studies by Thomas Gieryn. The question he and other scholars focus on is how borders between science and non-science are constructed and maintained ("boundary work").[31] The point of these studies is to find out why science has such authority in modern life, not by referring to inherent superior qualities of science but by showing how this superiority is constructed through social interaction. By constructing a certain image of their work, scientists put their specific discipline on the map, marked out against other scientific areas and non-scientific areas. In other words, scientists make classifications of science. Gieryn

[30] Latour, *Science in action*, 108-121. Woolgar, *Science the very idea.*

[31] Gieryn, "Boundaries of science." Fujimora, "Crafting Science."

stresses that boundary work by scientists and engineers is not an entirely unstructured process and relies on build-up repertoires. Nevertheless, the outcomes of these demarcation processes are not entirely predictable and can vary widely.[32] Moreover, boundary work not only implies fencing off a particular territory in science and practice, but also constructing modalities that enable interaction between various scientific fields as well as between scientific and non-scientific fields, science and practice.[33] In combination, boundary work relies on build-up repertoires, classification systems or other structures, enabling the construction of borders as well as the creation of similarities and linkages between science and practice. In analogy to the robots, what is considered a "movable object" and a "fixed object" is something scientists put together in complex ways, not obvious to an outsider, depending on the history of various iterations of the research game, and interactions between teams and fields.

## Objectives and methodology

With the various theoretical notions discussed in the previous section on board the scope and aim of this thesis can be further specified. Agricultural science is perceived as a set of activities of experts entitled to call themselves agricultural scientists or agricultural engineer (in its Dutch connotation) because they are affiliated with one of the scientific institutes created for the improvement of agriculture in the Netherlands and its colonies. This affiliation can either be through holding a job at these institutes and having received an academic title elsewhere or by holding the title 'agricultural engineer' by graduation at the education institute for agricultural science in Wageningen. The term 'agricultural science' directly hints at a specific purpose of the scientific activities, namely a connection with agriculture. This connection can take various shapes and forms, ranging from a mere focus of research, to development of technologies enhancing agrarian production or formulating measures and plans influencing the agrarian sector. Understanding agricultural science therefore directly entails an understanding of the connection between science and practice.

The development of agricultural science and the connection between science and practice is approached from a sociological perspective. A first aim of the thesis is therefore to show that the history of agricultural science in the Netherlands and its colonies is a fruitful terrain for sociological analysis. The development of agricultural science provides many interesting linkages with themes and issues that are central in Science and Technology Studies. Moreover,

[32] Gieryn, "Boundaries of science", 405-407.

[33] Ibid., 414-415.

a sociological interpretation of agricultural science provides agricultural scientists insight in the background and social formation of their own field. The basic sociological principle underlying this thesis is that scientific activities for agriculture and the organisation of these activities are considered as structured or institutionalised processes. Put the other way round, the agricultural-science institution is the result of all sorts of expressions and interactions that together define what agricultural science is and what not. In short, the agricultural-scientific institution is a result of classification and boundary work. This takes shape in various forms. In the first place there are interactions among agricultural scientists, resulting for example in assignment to a research or service institute, or assignment of a job description within such organisations. Another type is interactions with other professionals. These can be other scientists, like biologists or chemists affiliated to particular institutes, but also persons without academic training who claim expertise over (certain parts of) agriculture. A third type of interaction is between agricultural scientists and policy makers of the Dutch government, a major shaping force in the definition of agricultural science. Finally there are interactions with living and inert materials. Although these are not true social interactions, (changing) perceptions and interpretations of the materials agricultural scientists work with are important in determining the borders of agricultural science and the division of tasks and competence over various sub-disciplines. The second aim of this thesis, therefore, is to show the process of institution building through various sorts of interactions in and around the field of agricultural science, including the biological and non-biological materials of science.

The agricultural-science institution is primarily a social structure, but just as non-human materials and organisms play a role in human interaction, material or natural structures play a role in social structures. Regions with ecological similarity structure the activities of agricultural scientists. The distribution of scientific activities over various buildings favours or frustrates cooperation between scientists, etc. The continuity of these structures over time, whether through sheer replication, with slight adjustments or by major alterations, is a process that gains a certain momentum of its own. In re-establishing their activities and finding answers to new questions agricultural scientists (as anyone else) tend to go along grooves worn by the institution they are part of. The third aim of this thesis is, therefore, to show that a long-term analysis of the agricultural sciences results in a better understanding of the institutional dynamics in the field of agricultural science, including a better understanding of some of these institutional grooves.

## Methodology

The objectives set out above result in the task to come to grips with the institutional character of agricultural science in the Netherlands and its colonies over a period of more than a hundred years. A major consequence of the perspective adopted is that much of the analysis needs to home in on social interaction. Doing historical research excludes direct observation and registration of such interaction as agricultural science 'in the making'. But options and approaches are far from limited. The decisions made and angles taken, leading to the book at hand can be roughly divided in two categories. One is the themes and issues selected in the following chapters. The other is the selection and use of different sources.

From the start of the project there was a strong focus on the education of agricultural experts at Wageningen. The argument was that Wageningen graduates were considered to be the main shakers and movers of Dutch agricultural science. Consequently, the social and intellectual background of Wageningen graduates is crucial for understanding the agricultural-scientific institution. Education remained an important element in the analysis, but appeared to deliver an incomplete picture. That conclusion first came to the surface in the collected interview material. The large majority of interviewees stated that their study time in Wageningen was interesting and important indeed, yet they considered the early career phase after graduation to be the main formative period in respect of their professional quality. These accounts undermined the assumption that an understanding of higher agricultural education means a proper understanding of agricultural science. Moreover, from the interviews as well as from the written sources it appeared that research and education were hardly connected. In the first years the education consisted of textbook knowledge and examples, reflecting a professor's general textbook- knowledge of his discipline rather than knowledge acquired in recent research activities. In the last study phase students worked on projects that in some cases were related to on-going research work at Wageningen, but more often resulted from student interest and experience in a field-work period outside Wageningen. These findings resulted in a decision to look at research and education separately.

Besides the general organisational structure of education and research some detailed analysis of case material was necessary to get to the level where interactions as described above could be found. Regarding education the programme structure gave a relatively easy entrance. Between the 1890s and the 1950s there were five major education programmes in Wageningen. These were agriculture, forestry - each with a Dutch and colonial study track - and horticulture. Forestry was considered too far off from agriculture and horticulture only had a Dutch track, resulting in a decision to focus on Dutch and colonial agriculture. After the 1950s the division of the former colonial programme is followed as the tropical study directions were less numerous than the programmes focusing on the Dutch situation.

Regarding agricultural research the picture was far less clear. From the origin of the school most professors (formally teachers until 1918) had their own study objects and research interests, besides the activities of the experiment station, attached to the school. Form the division of student numbers over the study programmes as well as from the positions graduates obtained it became clear that the colonies were crucial for Dutch agricultural science. An analysis of agricultural research therefore could not leave out activities focused on overseas territory. The inclusion of the colonies might seem to complicate a selection of issues and topics, but the opposite was in fact the case. Because the education and research facilities in Wageningen were public services, it was rather obvious to concentrate on the public concern for agriculture, as expressed by the government. In the Netherlands as well as in the colonies much of this concern was about food security and in the Dutch East Indies this was almost equivalent to a sufficient rice supply. A first scan of the attempts of the colonial government to secure and increase rice production made clear that much of the work concentrated on rice improvement by using genetic variation in the rice species. The fact that food and genetics is a very explosive mixture in recent debates on agricultural science made the decision to concentrate on the genetics of rice easy. Consequently, the integration of genetics in agricultural science in the Netherlands became another topic, connected to a food-crop similar to rice, wheat. From an early stage the importance of inference, mathematics and statistics in agriculture was clear and the choice to concentrate on genetics in rice and wheat only strengthened the idea that this deserved a separate chapter.

The second category of methodological choices, the selection of source material, started off on the same ground as the selection of themes. Sources had to give information on the various interactions between scientists, policy makers, farmer representatives and others, providing insight in the construction of the agricultural-scientific institution. Regarding written sources it implied a focus on discussions and interpretations of selected themes and overall topics regarding agricultural science in the Netherlands and its colonies. Discussions and statements are often made in public, meaning that sources are reproduced and well distributed and always appear in a typed or printed format. Such sources are found in books, reports, journals, yearbooks and other series. Several series were worked through systematically, listed separately in the references. A substantial amount of information is distilled from pieces of text, short announcements and even adverts in such series - information that is woven in the text without reference. Besides public statements and debate, there are unpublished sources that only became publicly accessible after many years. These are documents, letters, internal reports and other papers, mainly stored in archives. The main value of unpublished sources is that they reveal views, initiatives and activities that cannot be traced in published sources. Going through archives implies that sometimes days are spent without much result, and much more effective in that respect are source publications. A third type of written sources is secondary literature, histories, biographies, memorial books etc. Chapter two is entirely based on this type of literature and it proved to be of value in all other chapters.

Besides the written sources a very special input in the thesis originates in oral histories. Over the research period forty interviews were made with graduates from the Agricultural College and some graduates of the Agricultural University. Interviewees were selected from three groups. The first were agricultural experts graduated before 1940, the second graduates between 1940 and 1960, and the last, those who graduated after 1960. Persons to be interviewed were further selected by the education programme they followed and the variety of positions and countries of employment. Preference was given to graduates who held positions in the Dutch East Indies or other non-Western countries. Consequently, the majority of interviewees followed one of the colonial or tropical study programmes. The reason behind this selection was to get an idea of the scope and reach of the Dutch agricultural-scientific institution. The Wageningen institution was primarily designed as public-sector support to Dutch agriculture but also delivered experts for public and private agricultural institutes in the colonies, and later (under aid programmes) to agricultural research institutes all over the world from the 1950s. Views and experiences of graduates with career paths reaching outside Europe give an idea of the geographical impact and limits of the Wageningen institution. Moreover, the majority of interviewees of the first and second group only spent part of their careers in the South and mostly continued in one of the public or private sector agricultural organisations in the Netherlands. Below, some more will be said about the international character of Dutch agricultural science. The information gained from the interviews revealed an element that appeared crucial in the analysis and runs through all the following chapters, the relation between science and practice.

**Science and practice**

In the previous section, when the role of the interviews in the selection of research themes was discussed, it was pointed out many graduates considered the early career period as more influential in the formation of their professional knowledge and skills than education in Wageningen. However, none of the interviewees considered the study period a waste of time and energy, raising the question what exactly the value of the Wageningen study programmes was? The common element in the answers given by the interviewees was the variety and scope of the study programme. As worked out in detail in chapter four, this variety was included in the programme structure through compulsory course elements until the 1950s, and through a relatively large space for optional courses from the 1960s on. According to the interviewees this broad study background allowed them to pick up and work out issues they encountered in their work environment quicker and easier than many of their colleagues trained at other institutes. This quality was by many employers considered advantageous as it allowed Wageningen graduates to collaborate and exchange expertise with colleagues with various – and often more specialised – backgrounds. The crux in the accounts of the interviewees is that the large majority, regardless of age-group, stated that they acquired this integrative and broad expertise despite rather then because of the programme structure of the Wageningen education. Interviewees from all age groups stated that professors and lecturers hardly ever referred to each other's courses and were of little value by themselves in building up a coherent curriculum. In other words, interviewees considered their broad basis and integrative capacity primarily resulted from their own efforts during the study period and early career phase. Moreover, various interviewees had negative experiences when trying to get some feed-back from their teachers regarding problems they came across as practitioners. Although not every interviewee looked for such contact, those that did all stated that responses varied from feigned interest without any concrete follow-up to a straightforward rejection of the problem or approach presented by the former students.

These accounts reveal a certain gap or clash between the Wageningen institution and the field where Wageningen graduates worked as practitioners. This gap can be interpreted in different ways. One option is to consider the gap as a difference in mental stages. What people in their late teens and early twenties could absorb might be different from their mental capacity at later age. Although such a difference might play a role, it does not explain why the gap remained apparent when graduates sought contact with their former professors later on in their professional career. On a more general cognitive level the gap can be explained as a difference between theory and practice. Issues and problems explained and discussed in textbooks, the lecture room or laboratory setting mostly appear very different and often less complicated than in practice. Professors and lecturers work primarily in classroom and laboratory environments, but their former students are active in much more diverse situations. Approach, definition, experience and knowledge develop differently in the two settings. Although this interpretation comes close to the perspective taken in this book, it misses one element that emerged in the interviews. Almost every interviewed graduate changed employer and work environment. Several of them worked for a period in one of the agricultural research institutes or education services falling under authority of the Dutch Ministry of Agriculture, including the college (and later university) in Wageningen. Several graduates noticed that the 'gap' was far less present in that working environment compared to working in other institutes. Especially at the Wageningen research institutes, formally independent from the college since the late 1940s, working methods, contacts and approaches appeared much more in line with the work of the professors and other employees of the Agricultural College in Wageningen. This points to a social dimension in the work of professors and their staff on the one hand and the various work places Wageningen graduates found themselves in on the other. This social dimension is interpreted as an institutional difference (or similarity), referring to the notion of institution as explained above.

Consequently, the 'gap' between professors and graduates, first rising to the surface in the interview material, is interpreted as a disturbed relation between science and practice. The distinction or relation is termed 'science and practice' contrary to the more common designation 'theory and practice' because it is not only about theoretical abstractions, but also about human activity and contains an institutional dimension, elements inclusive to the term 'science'. Many of the interviewees considered the relation between science and practice as disturbed, or as a gap. For readers following developments in agriculture and agricultural science in recent years, whether in the Netherlands or other countries, that conclusion will not come as a surprise. Consumers of agrarian products as well as 'users' of the countryside appeared to have very different interpretations of healthy food and ecological balance than many (agricultural) scientists. This disturbed relation between science and practice, also present in the second opening quote, originated in a period that falls largely outside the time frame of this thesis, but the issue returns in the final chapter. The main point for now is that the relation between science and practice was not always so problematic in every time and situation. Therefore, the articulation of the connection between science and practice, as it varies across times and places, forms a major thread through all chapters.

**Agricultural science as an international field**

A last element emerging from the material analysed in need of some further specification is the international dimension. It is generally known that (agricultural) scientific disciplines stretch over many institutions in a large number of countries. Less known is that the multinational enterprise called 'science' is not a phenomenon from recent decades but a feature present in science since the creation of the very first universities. Regarding the period covered in this thesis, agricultural science was in many ways an international business too. This relates to the Western world as well as to the colonial territories of the various European countries. In this thesis however I restrict myself to analysing the scientific institutions created by the Dutch government focused on agriculture in the Netherlands and its colonies. This study therefore, first of all, reveals the characteristics and peculiarities of agricultural science in the way the Dutch have done it. Nevertheless, because of many interactions between Dutch agricultural scientists and foreign researchers and teachers, there will be many features shared by agricultural science institutes in other countries. Although a comparison with other countries is not part of the analysis, the international character of agricultural science breathes through the story, one of the reasons why this thesis is written in the English language.

The international character of Dutch agricultural science is also apparent in the analysis more directly. Until the second half of the twentieth century the Netherlands were a major colonial power in Europe, governing territories in South East Asia, the Caribbean and South America. The Dutch established various institutes for agricultural research in their colonies and some years before the independence of Indonesia, the major territory under Dutch colonial rule, they created an agricultural faculty on Java, providing scientific education in agriculture. The independence of Indonesia implied that all Dutch functionaries were expelled from the public services and had to leave the country. A large part of the scientific staff members working at the agricultural research institutes in the Indonesian archipelago was educated in Wageningen. Nevertheless, the facilities for education in tropical agriculture in Wageningen were not discontinued but expanded. Servicing the relatively modest agricultural research institutes in the remaining colonial territories was one objective, but emerging international development cooperation, and the various institutes and facilities that then arose, implied new job opportunities for graduates in one or other of the education and research programmes directed at tropical agriculture. Although Wageningen itself is like the Netherlands located in a temperate climatic zone, knowledge and experience about tropical agriculture is reproduced, updated and transferred up to the present day. Many of the peculiarities (but also more structural features) of agricultural science in the Netherlands are a product of this specific international dimension, a product of the colonial expansion of the Dutch. It is not a direct aim of this thesis to prove or map the global distribution of knowledge and technologies produced by Dutch agricultural scientists. But it needs to borne in mind that the international character of science and the colonial past of the Netherlands make Dutch agricultural science in fact a world-wide Dutch enterprise.

Some more words need to be said about colonialism. The original meaning of a colony is a trading post and obtaining goods, valuables and slaves was the main incentive for European nations to cross the waters. The step from trading posts to territorial rule was made rather quickly, although some colonising countries considered this more important than others. Roughly from the late eighteenth century, territorial rule - and in response the fight for freedom and independence - became the central force of colonialism. From that moment on, the Netherlands and its colonial government developed all sorts of policies that affected the entire population of the colonised territories. Two examples of such policies, food supply in relation to rice improvement and taxation in relation to statistics, are analysed in more detail in this thesis. In these and other themes that play in the context of colonialism, the overall aim is to analyse the events and developments in terms of their impact on agricultural science. In other words, the development of colonialism as such is not part of the analysis. Nevertheless, there is a sort of derived meaning in the way the colonial context is considered in this thesis. In many historical and current sociological accounts the decolonisation period is mostly considered as a watershed. All that happened during colonialism stopped with the independence and current developments have their starting point at independence day. Although this is a general impression resulting from readings and not a result from concrete analysis, I hope to show in this thesis that events and developments in (tropical) agriculture and agricultural science under colonial rule have direct relevance to understand scientific practice in Europe and former colonised territories. Furthermore, I am convinced that scientific activities and technological development under colonial rule is an underexposed terrain for historical and sociological analysis. In short, colonialism is not only a period in history characterised by slavery, suppression and exploitation but also a period with many interesting and less coercive activities, not any less meaningful than all the nasty deeds. Particularly this relates to the proliferation of scientific activity that has become both part of the local and international heritage.

## Layout of the thesis

In the methodology section the major decisions leading to the book at hand have already been pointed out. The resulting contours of the research project still leave open many issues and topics that might have been included but are left out (or the other way round). Telling the complete story of agricultural science is not part of the objective, but there surely is the ambition to tell a complete story. In other words, the history of agricultural science is sliced up and displayed in a way that does not contain every detail, but hopefully does result in a full picture.

In the next three chapters I try to capture the major features of agricultural science in the Netherlands and its colonies. In chapter two the question is asked what the landscape of agricultural science looked like before the Dutch government started to interfere and invest seriously in innovation by science. The assumption that agricultural science is highly dependent on government initiatives regarding agriculture is taken as the guiding principle throughout this chapter. For that reason the chapter starts at the end of the eighteenth century when a state form with the national territory as main reference took shape. The national territory included the rural areas and policies were formulated to make use of and develop this part of the nation. The leading question in this chapter is, therefore, how the various parties later to establish agricultural science at the end of the nineteenth century found each other and became ready to take the step. The question is asked for the Netherlands and the Dutch East Indies separately. In chapter three the focus is on the organisation of agricultural research. In the Netherlands agricultural research started as a government activity, organised in experiment stations, the first opened in Wageningen in 1876 and followed in the 1890s by some more in different locations. From the early twentieth century other organisational forms of agricultural research emerged, public as well as private, but the focus is on the public institutes. In the colonies the first experimental stations were created by private planter organisations. Research for agriculture, however, was also a major issue for the Botanic Garden, a public sector research centre that became the core of a newly created colonial Department of Agriculture in the early twentieth century. Similar to the situation in the Netherlands, a major issue was how the different forms of agricultural research should be adjusted and arranged and this process is followed in the colonies and in the mother country. In chapter four the education of agricultural scientists in the Netherlands is analysed. As explained previously, the scientific training in agricultural issues took place in different organisational formats, but all located in the Wageningen institution. In other words, in the chapter on scientific education for agriculture the focus is almost entirely on the institution in Wageningen. The main questions asked in analysing the debates about the education are what was considered the objective of scientific agricultural education, what was considered an ideal study programme and how did this all play out in the concrete organisation of education and teaching activity?

In chapters five to seven the structural features of agricultural science in the Netherlands and its colonies are further explored. In chapter five the development of plant genetics in relation to plant breeding in the Netherlands is followed. Many elements presented in chapters three and four will return, this time in a concrete case where most attention is given to the improvement of wheat varieties in the Netherlands. The main question addressed by the various participants in that development (and also the leading question for the chapter) is what proper plant genetics and breeding looks like and how can it serve Dutch agriculture? Furthermore, the impact of these debates on the concrete organisation of genetics and plant breeding in general, and wheat breeding in particular, is followed. In chapter six a similar exercise is done for rice breeding in the colonial context. Research on the genetics of Javanese rice was a direct implementation of the policy of the colonial government to increase the food production. Visions on the best format of rice breeding differed and various initiatives were taken, some of which failed, some of which succeeded. Rice breeding is not only analysed in the context of the Indonesian archipelago but also followed in the context of Surinam. In chapter seven a founding element of agricultural science is analysed, agricultural statistics. Statistics is approached in a broad sense, covering various techniques to move from the particular to the general by numerical abstraction. The leading question in this chapter is how this statistics integrated with agricultural science? Three major fields of application are analysed. After discussing the background of statistics in general and the early developments in Dutch agriculture, the development of numerical abstraction is first followed in the context of analysis of colonial farm households, conducted by extension officers and resulting in the discipline of colonial agrarian economics. Secondly the emergence of field experimentation through mathematical statistics is analysed, primarily in the Dutch context. Finally, a particular branch of numerical abstraction in the agricultural sciences is analysed, the construction of mathematical or physical models of crop growth. In chapter eight the major findings of the various chapters are wrapped up and developed into a final set of conclusions. A short outlook on recent developments in agricultural science is made, answering the question how much are the findings of study relevant to current debates and concern?

**Time, names and language**

Before the story will unfold some more things need to be said about the time frame used in this thesis and the background of some choices in formulation and translation. To start with the time frame, the title of the thesis mentions two concrete years, 1863 and 1986. The first year is the year a new education act became effective, arranging all sorts of schools of so-called Middle Education (*Middelbaar Onderwijs*) a layer in the education system situated between lower and higher education. Agricultural schools were included in that law, and one agricultural school was supposed to offer scientific education. This law initiated the creation of a school and experiment station in Wageningen in 1876 and in that way can be considered as the starting point for public agricultural science in the Netherlands. The other year, 1986, was the year the major institution for agricultural science in the Netherlands changed its name from Agricultural College (*Landbouwhogeschool*) to Agricultural University (*Landbouwuniversiteit*). This name change was again an effect of a change in the education system. Although the amendment of the Higher Education Act implied more than a change of name, the fact the former Agricultural College was allowed to call itself a university must be considered as a pinnacle for the institution. As this thesis will show, the urge to acquire the status of university, have the same prestige in research, and provide education of the same academic level played an important role for the institution in Wageningen as well as for the development of Dutch agricultural science in general. In other words, in 1986 the institution became what it always wanted to be and for this reason it is a proper year to end the period covered in this thesis. But of course the history of Dutch agricultural science does not end in 1986 and the law of 1863 was not a sudden move by the government. Therefore, these years have some arbitrariness and are not considered strict borders. All chapters start a bit earlier, taking up some of the relevant developments before late nineteenth century, linking up with chapter two. Likewise, not every chapter ends exactly in 1986 and especially in the final chapter a short outlook is given on the period after 1986, tracing several recent developments that link with the earlier history.

A second thing I have to inform the reader about concerns (geographical) names and translations. All translations of Dutch words and quotations are mine, except when the reference contains a title in English. As there are no fixed rules or guidelines for translation I found myself a way out of this, learning from other authors writing about the history of the Netherlands and its colonies in the English language. A major decision concerns the choice to follow the British English as preferred spelling. But not every translation is simply a matter of personal preference and pragmatic reasoning. Over the years I had various discussions with Dutch 'experts' about proper translations. A Dutch historian remarked that I should use experimental station and not experiment station, but both are used in the literature and in my reasoning what is experimental are the activities at the station and not the station as such. To qualify the station the activity is added, to experiment, resulting in experiment station. A more interesting argument about the same term came from one of the interviewed agricultural scientists. He argued that there is a specific Dutch interpretation of the entity *proefstation*. As the major orientation of (agricultural) scientists in the nineteenth century was towards Germany, this is probably a translation of the German word *Prüfstelle*. But (he argued) the way the Dutch set up these stations was different from the stations in Germany or Britain, and a mere translation in experiment station does not cover that. Nevertheless, experiment station is what is used in the text. A similar argument was made about the word *hogeschool*, in the Dutch spelling from before the second World War *hoogeschool*. This word too resembles the German word

*Hochschule*, but according to some colleagues is a typical Dutch phenomenon. What it denotes is a form of professional education arranged in the Higher Education Act, though so far as I know not only present in the Netherlands. The translation chosen in this thesis is 'college', so *Landbouwho(o)geschool* will be referred to as the Agricultural College and the *Technische Hogeschool*, located in Delft, is translated as Technical College, equivalent in British usage to 'Polytechnic', aterm abandoned in the 1990s in favour of 'university'. For these and other nominators the Dutch equivalent is mostly added in italic and sometimes only the Dutch name (in italic) is used when the word frequently comes up in a paragraph. An exception is when I refer to the Ministry of Agriculture. The history of this ministry is characterised by various name changes and connections with other government departments. Before the 1930s a separate Ministry of Agriculture did not exist. Agricultural affairs were dealt with by a Directorate, *Directoraat*, part of several ministries over the years, some of which included a reference to agriculture in the name but never their main activity. After the 1930s agriculture was the main affiliation of a ministry, but always other elements were included in the name. The most faithful partner-name is 'fisheries'. After the second World War 'food supply' was included in the name for some years and in the 1980s 'nature conservation' became a prominent element. Unless such name changes are relevant for the story, they are not mentioned and the ministry is referred to as 'Directorate of Agriculture' in situations before the 1930s and 'Ministry of Agriculture' from that decade onwards.

A linguistic problem of a different nature concerns names and places in the former Dutch colonies, especially the area now called Indonesia. The archipelago was in Dutch fully called *Nederlandsch Oost-Indië*, but often simplified to *Nederlandsch-Indië*, *Oost Indië* or *Indië*. The Dutch themselves often translate the adjective or possessive form of their country's name in the same way resulting here in Netherlands Indies. They probably do so because 'Dutch' has all sorts of dubious connotations in the English language and for the Dutch themselves it probably resembles to *Duits* (adjectival form of Germany), mostly not implying a very positive qualification either. Anyway, I prefer to use Dutch East Indies. The capital of Indonesia, Jakarta, was in colonial days called *Batavia* and the major city where the agricultural institutes were (and still are) located is Bogor, under Dutch rule called *Buitenzorg*. These Dutch names will be followed through the text, based on the argument that the geographical and political context from the post-independence period is not more clarifying for events happening in a pre-independence (colonial) context. For readers wanting to check geographical references on a recent map or have such map in their heads, current names are now and then added in brackets. Based on the same argument, for the many names of places that did not change after independence, the original Dutch spelling is used. This spelling is more or less phonetic (for a Dutch reader). The Dutch spelled *Tjiandjoer* where the Indonesians now use Cianjur and English readers will come closest to the correct pronunciation when using the Indonesian spelling. What is correct and what not is a complex issue as the village is located on Java, the main island of Indonesia that had and still has some regional languages of its own, including its own script, but neither before nor after colonial days an official language. In short, I will follow the spelling mostly used by the people and in the social environments the story concentrates on, now and then clarified by Dutch translations and by context.

# 2

# Agricultural science in the nineteenth century

## Introduction

The period covered by this thesis is marked out by two changes in the Dutch education system, entailing major consequences for agricultural science. The new education law enacted in 1863 initiated the creation of a school and experiment station in Wageningen, growing over the years into a large institution for agricultural research and education. Although major developments in the second half of the nineteenth century are described over several chapters, these elements together form a story worth telling. Moreover, developments never start from scratch and in order to understand why the year 1863 was so crucial, ideas, debates, organisations and movements need to be followed back further in time. In this chapter that challenge is taken up through an overview of secondary literature on the issue. Consequently, and in order to avoid any misunderstandings, this chapter is primarily supportive to rather than crucial for the analysis of agricultural science in the Netherlands and its colonies between 1863 and 1986. Nevertheless, this chapter tries to shed some light on a particular feature of Dutch agricultural science, rooted in the nineteenth-century developments and bearing consequences for its development in the twentieth century. This feature concerns the organisational and legal embedding of agricultural science. What will become clear is that it took more then a century before a proper and lasting organisational and legal format was found. Moreover, the process and outcome differed considerably over the Netherlands and the Dutch East Indies. The main elements that we need to come to terms with are government, science and agriculture.

The interest from the government for agriculture and its improvement through science emerged early nineteenth century. The focus was primarily on education of the scientific principles of agriculture. Scientists in their turn were mainly dependent on the facilities provided by the public universities or direct assignments by the government. Moreover, scientists were dependent on the available knowledge and experience to understand and tackle agricultural issues. Finally, there needs to be some sort of expressed demand for scientific support by representatives of the agrarian community. As will become clear, such expressions are not necessarily balanced and well-discussed reflections of the general opinion of a majority of farmers. In the Netherlands and certainly in the colonial territories the needs of the agrarian community to which science had to contribute was mostly expressed by people closer to the government or science than to the farming community. These three structuring elements of agricultural science are examined in two parts. The first part gives an overview of the major developments leading to the establishment of agricultural science in the Netherlands. The second part homes in on the Dutch East Indies, and is mostly limited to developments on the main island of the archipelago, Java.

## Science and agriculture in the Netherlands

Before 1795 the political structure of the Netherlands was a congregation of relatively autonomous state-like provinces dominated by Holland and Zeeland. The political system had an overall urban bias and was led by an elite of merchants. Decisions that concerned all regions in the Netherlands were taken by an assembly of the States General, *Staten Generaal*, that assembled for the first time in 1464. The main item discussed by the States General was the defence of the shared interest of the participating parties, often meaning military affairs, as the Dutch state-provinces revolted against the rule of various European monarchs, resulting by the end of the sixteenth century in the formation of the Republic of the United Netherlands. The revolt was based on religious as well as economic interests and the main source of income was the trade of all sorts of products from all over the world.[1] The cities close to the sea or one of the rivers were the major centres of social, economic and political activity. The countryside supported the cities by growing food for the citizens, and in case of warfare by forming a barrier to hostile troops through inundation of the land.

A major difference between the Netherlands and its larger neighbours was the absence of a large and influential landed aristocracy. In countries like Germany, England and France, where the landed nobility had relatively much political power and social status, attention for agricultural matters was, consequently, an issue on the agenda of the ruling classes. That is why modernisation of European agriculture in the late eighteenth century is generally attributed to various members of the rural elite, like Jethro Tull (1674-1740) and Arthur Young (1741-1820) in England, Albrecht D. Thaer (1752-1828) in Germany and Henri L. Duhamel du Monceau (1700-1782) in France.[2] Although the writings of these men were unmistakably influential to late eighteenth-century and early nineteenth century European agriculture, it can be questioned whether the source of innovation was really their own activity. Agricultural historians have pointed out that innovation in agriculture was much more a long-term development than a revolutionary change, stemming from farm experience moving through Europe by all sorts of travelling 'agents'.[3] Moreover, it is questionable whether the influence of these men on agriculture is based on their erudition in the subject or because of their social and political position. In the case of Arthur Young, for example, the latter seems more likely than the first.[4] Another argument to question the importance of these men for agriculture is the fact that in the Netherlands the influence of the landed nobility on agricultural innovation was relatively

[1] Stuurman, *Wacht op onze daden*, 55-93. Israël, *The Dutch Republic.*

[2] Van der Poel, *Heren en boeren.*

[3] Slicher van Bath, *The agrarian history of Western Europe.* Kerridge, *The agricultural revolution.*

[4] Kerridge, "Arthur Young and William Marschall", 45-53.

insignificant, but agricultural development certainly not lacked behind compared to other countries.[5] Nevertheless, the lack of a prominent landed aristocracy in the Netherlands did have consequences for the position of agriculture on the political and academic agendas. Regarding the latter, agriculture was an element of university teaching in the eighteenth century. Agricultural topics were integrated in courses in rural administration and similar political-economic items as for example in the *Cameralwissenschaften* at the German universities, a discipline professed by Thaer.[6] In the Netherlands there was hardly academic attention for agriculture, except for individual cases like Petrus Camper (1722-1789), zoologist at the University of Groningen. He experimented with treatments that could control the rinderpest and did tests with farm machinery. The writings of the foreign innovators were available in the Netherlands too and several large farmers copied the experiments, but land-owning support for innovation was less marked.[7]

In 1795 the revolutionary civil movements and changing power balance in Europe resulted in a new state form in the Netherlands, called the Batavian Republic. One of the main new elements of the new republic was that no longer the shared interest of the cities and provinces were the basis for governance, but the national territory. A central state administration was created issuing laws and formulating policies covering the entire Netherlands. An important effect of this new state form was the role of the country side. Rural areas, agriculture and the rural population became more important and visible in various activities of the state.[8] The first concrete measure came in 1799 and comprised the creation of a cattle fund to compensate farmers for losses caused by the rinderpest.[9] A year later an Agency for Agriculture was created, a position held by Jan Kops (1765-1849). Kops concentrated on two issues: assembling information about Dutch agriculture and stimulating innovations. He tried to achieve both targets by installing in each province a Commission for Agriculture (*Commissie van Landbouw*). The commissions were rather independent regarding the introduction of innovations, but the assembly of information about agriculture was centrally administered and prepared by Kops into "States of Agriculture" (*Staten van Landbouw*) the first official statistics of agriculture in the Netherlands.[10]

The Batavian Republic was gradually taken over by French rule and the defeat of the French armies at Waterloo also implied the end of the Batavian Republic. In 1813 the Dutch state became a monarchy, headed by king William I. The government of the king continued many of the initiatives and measures taken by

[5] Van Zanden, *The transformation of European Agriculture*, 11-20.

[6] Van der Poel, *Heren en boeren*, 19.

[7] Ibid., 34-57. Visser, *The Zoological work of Petrus Camper*.

[8] Van der Woud, *Het lege land*, 195-242. Sneller, *Geschiedenis van de Nederlandse landbouw*, 82-122.

[9] Bieleman, *Geschiedenis van de landbouw in Nederland*, 160-166. Van der Poel, *Heren en boeren*, 34-57.

[10] Van der Poel, *Heren en boeren*, 78-41. Van Zanden, *The transformation of European Agriculture*, 27-32.

the Batavian and French rulers, but not the attention for agriculture. The State Agency for Agriculture was dissolved after Kops exchanged his government function for a university chair. The Commissions of Agriculture remained intact but had little support and were formally disbanded in 1851.[11] During the reign of William I the decreasing government interest in agriculture resulted in what is often denoted as a *laissez faire* politics, a situation lasting from about the 1830s until the 1860s.[12] This liberal policy however does not mean that the state was completely inactive. William I invested large sums of money in rural infrastructure to improve water management and transport facilities, affecting agriculture directly and indirectly.[13]

Another element arranged during the reign of William I was a change in the legal arrangements for universities. The government of the Batavian republic already started with a revision of the complete education system, of which only the innovations for primary education were implemented. In 1815 the higher education system was reorganised by royal decree. One of the changes was the introduction of chairs in Land-household studies (*Landhuishoudkunde*) one of the very few vocational elements in the new higher education act.

**Agriculture and universities**

The first university in the Netherlands opened its doors in 1575. The location was Leiden and the university was a reward by the Prince of Orange for the courage of the citizens during the Spanish siege of 1573-1574. In the seventeenth and eighteenth century four other universities were founded as well as a dozen so-called illustrious schools or *athenaea*, which were university-level institutions without graduation rights.[14] In the early nineteenth century several revisions of the education system appeared. Regarding higher education the designs included various forms of vocational training. However, during the period of Batavian-French rule higher education remained unchanged and it was the government of King William I that realised new legislation for higher education. The king assigned a committee that made an extensive plan regarding various aspects of higher education including lectures that were not considered to be academic, but scientific enough to be integrated in the academic system.[15] The decree of 1815, however, had erased all those elements from the text of the law, except for the chairs in land-household studies (*landhuishoudkunde*) in the faculty of Physics

[11] Van der Poel, *Heren en boeren*, 78-41.

[12] Vermeulen, Den Haag en de landbouw, 7-37.

[13] Van der Woud, *Het lege land*, 95-194.

[14] Baggen, *Vorming door wetenschap*, 21-55. Frijhoff, "The Netherlands", 491-504.

[15] Roelevink, "Rapport van de commissie van der Duyn van Maasdam", 16-61. Baggen, *Vorming door wetenschap*, 58-63. Wachelder, *Universiteit tussen vorming en opleiding*, 62-80.

and Natural Science. Jan Kops occupied the chair in land-household studies at the University of Utrecht. In Leiden it was Christiaan F. Kleijnhoff van Enspijk (1761-1819) and Jacobus A. Uilkens (1772-1825) was appointed as professor in land-household studies at the University of Groningen.[16] The designation land-household studies (*landhuishoudkunde*), was the rural version of state-household studies (*staathuishoudkunde*) and both areas had a background in statistics and economy. Land-household studies, however, was not just about the economic principles of agriculture, but also covered chemistry, natural history and physics. With the installation of these professors, agrarian issues had a place in the Dutch university system. Entrance to a university, however, required a schooling track that was rather costly and very few farmers could afford to send their sons to one of the academies. Therefore a connection had to be made between the university lectures and the practising farmers.

The inclusion of land-household studies in revision of the higher education system is somewhat remarkable as other vocational issues were left out of the arrangement. Allegedly, the decision of the king was inspired during his exile in Prussia where he was informed about the education structure there. In various German universities agriculture was one of the subjects for many years and around the turn of the century specific agricultural academies emerged. Albrecht Thaer, for example, attached a teaching institute to an estate near Berlin in 1806 that was granted a charter as the Royal Agricultural Academy in 1819.[17] The students of these universities were mostly sons of landowners, and thereby estate holders were made familiar with the main principles of agriculture and the management of estates. In that way the lectures had a direct linkage with agriculture, albeit the agriculture of the rich. In the Netherlands the number of landowners and estate holders was relatively insignificant compared to the total of small peasants. The king and his advisors were aware that they could not rely on rural elite to attend the lectures in land-household studies. Therefore another target group was selected to transfer the knowledge to the rural areas. The lectures were made compulsory for theology students with the idea that the majority of these young theologians would become preachers in the countryside. The idea, however, appeared difficult to establish because the Dutch Reformed Church considered a combination of the Bible and the plough a mixed blessing, and church elders frequently complained about the compulsory status of the lectures in land-household studies. The protests were effective and in 1820 the compulsory status of the lectures was limited to only the first year. In 1831 the lectures became entirely optional. Consequently, very few students showed up, affecting the professors not only in their prestige but also financially as they received most of their income from the tuition fees, paid directly by the students. In

[16] Goudswaard, *Agrarisch onderwijs*, 60-63. Van der Poel, *Het landbouwonderwijs*, 23-29.

[17] Goudswaard, *Agrarisch onderwijs*, 35-38. Van der Poel, *Heren en boeren*, 17-21.

response, H.C. van Hall (1801-1874), successor of Uilkens in Groningen, proposed to make the lectures accessible for the general public. The idea, as such, was rather revolutionary in those days, as students were considered a special social category, but a petition of all professors in land-household studies was approved in 1840. The efforts of van Hall opened the possibility for the farming community to attend academic lectures without any requirements, but with the exception of the lectures in Groningen, very few people showed up.[18]

The chairs in land-household studies, installed at the Dutch universities in 1815, were the first formally arranged facility for the development of agricultural science. The chairs were partly an effect of the changes in the education system, prepared by the government of the Batavian Republic and implemented by the government of king William I. In part they also reflected broader government policy in the early 1800s. The chairs however lacked a clear linkage with agricultural practice. Although the idea to broaden the tasks of future preachers was certainly imaginative it did not work out. Halfway through the nineteenth century the lectures in land-household studies were hardly attended and incorporated in the assignments of other professors, with the exception of the university of Groningen. The chairs were abolished in the next major restructuring of the system of higher education in 1876. The chairs can be considered as the first facility for agricultural science in the Netherlands, even though they vanished in the course of the nineteenth century. Besides the institutional limitations and no real link with agricultural practice, the approach to agriculture in the lectures of land-household studies gradually was taken over by other fields.

## Experimentation and agriculture

Land-household studies, as lectured by Kops and the other professors, can be characterised as a descriptive science, based in the classical approach of statistics. The lectures contained overviews and comparisons about different modes of farming, details about the taxonomic features of crops and the chemical substances they contain. Innovation was based on experiments in the field with methods, plants or tools, copied from elsewhere. From the 1830s a new approach to phenomena in nature and agriculture came up, most prominently in chemistry and biology. The leading figures in the new approach were Justus von Liebig (1803-1873) and Charles Darwin (1809-1882). The influence of the changes initiated by the work of these scientists is traceable in the Netherlands and its colonies. Due to the natural conditions, however, chemistry became a more pronounced issue in the Netherlands, whereas botanical issues dominated the establishment of agricultural science in the colonies. Therefore the two issues are discussed separately, and Darwin will show up in the next part of the chapter.

[18] Addens, De vereeniging voor hooger landbouwonderwijs. Van der Haar, Geschiedenis I, 27-30.

Justus von Liebig is generally seen as the founding father of modern agricultural science and the main pioneer in organic chemistry.[19] Von Liebig openly attacked the traditional ways of experimentation in organic chemistry in general and its application to agriculture in particular. He accused traditional chemists and physiologists of conducting experiments that were valueless for the decision of any question because performed without any idea what the range of the experiment was. According to Liebig a proper experiment required a theory that provided insight in the conditions under which a hypothesis could be rejected or accepted.[20] The main question for experimentation in agriculture was generally if the change 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. The weight von Liebig gave to experimentation is also visible in the education reforms he introduced. He and the British chemist Thomas Thomson were the first scientists in the nineteenth century to create academy-based laboratories in which students actively participated in chemical analysis and experimentation.[21] Von Liebig had a strong aversion against traditional academic requirements. He admitted any student he considered talented, and many of them had not attended (or finished) the gymnasium, the principle requirement for admission to a university.

Von Liebig was first of all a chemist and in the Netherlands his work was first read and discussed by chemists, many of them with much scepticism. Especially G.J. Mulder (1802-1880), professor in chemistry at the University of Utrecht openly disagreed with Von Liebig's views on the role of organic substances for plant nutrition. Another Dutch chemist sceptical about von Liebig's work was A.H. van der Boon Mesch (1804-1874), professor at the University of Leiden since 1836 and from 1840 also commissioned to give the lectures in land-household studies. Although the Dutch chemists often disagreed on the content of von Liebig's work, they agreed on the importance of experimentation. Mulder for example promoted laboratory training, especially in medical study and also promoted the use of chemical experimentation for agriculture.[22] The work and ideas of Von Liebig inspired many chemists all over the world to set up agricultural experiment

[19] Rossiter, *The emergence of agricultural science*, 10-28. Snelders, "Landbouw en scheikunde in Nederland", 59-104.

[20] Krohn and Schäfer, "The origins and structure", 27-52.

[21] Morrell, "The chemist breeders", 1-46. Homburg, *Van beroep 'Chemiker'*, 319-328.

[22] Wachelder, *Universiteit tussen vorming en opleiding*, 95-110. Snelders, "Landbouw en scheikunde in Nederland", 59-104.

stations, often funded by private farmer organisations.[23] In the Netherlands there were several initiatives to do the same, but the plans were not realised until 1877. In that year a State Experiment Station was opened in Wageningen, headed by the German chemist A. Mayer (1843-1942). The development of the experimental approach in organic chemistry and the response by Dutch chemists was supported by agricultural societies, active from the 1840s.

### Agricultural organisations

During the 1840s prominent figures in the rural and urban society founded provincial agricultural societies in order to defend the interests of farmers and support progress in agriculture. The main support for these societies came from estate holders, scholars and notables. The founding board of the Holland Society of Agriculture (*Hollandsche Maatschappij van Landbouw*) in 1847 for example consisted of one baron, two esquires, two lawyers and a professor in natural history from the Amsterdam *Athenaeum*, F.A.W. Miquel (1811-1871).[24] Several of these societies had ordinary farmers among their members but never on the board of governors. From 1846 the agricultural organisations arranged joint meetings in combination with exhibitions called *Landhuishoudkundig Congres*. These fairs were national events taking place in a different city every year, and lasting several days. The leading figures of the societies expressed their views on the state of Dutch agriculture and what should be done to improve it. Every year there were many recurring themes and, for several issues, special commissions were installed to report to the congress about the progress towards solution.[25]

One of the driving forces behind the establishment of the agricultural societies was the diminished interest of the government to arrange agricultural matters. 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.[26] As the boards of the agricultural organisations hardly contained small farmers their voice was not heard and the organisations supported the abolishment of the commons. But the organisation had other wishes received with less enthusiasm by the government. Several issues frequently

[23] Rossiter, *The emergence of agricultural science*, 117-171. Koning, *The failure of agrarian capatilism*, 52.

[24] Waldeck, *Beknopt overzicht van de oprichting en werkzaamheden*. Vermeulen, *Den Haag en de landbouw*, 30-37.

[25] *Verslagen Landhuishoudkundig Congres*.

[26] Sneller, *Geschiedenis van de Nederlandse landbouw*, 82-122.

returned on the agenda of the annual fairs but the three main items were the compilation of encompassing and reliable agricultural statistics, proper agricultural education, and laboratories for chemical analyses of agricultural inputs and products. A leading figure in the commissions and discussion about agricultural statistics and education was W.C.H. Staring (1808-1877). Staring was a graduate of the University of Leiden and wrote a dissertation on the geology of Dutch soil, after which he returned to his family estate in the east of the Netherlands. He was a member of the Commission of Agriculture of the Province of Gelderland from 1841 and one of the founders of the Gelderland Society of Agriculture (*Gelderse Maatschappij van Landbouw*) in 1847.[27] Staring was chairman of several commissions of the agricultural fairs (*Landhuishoudkundig Congres*). Between 1860 and 1874 he was the official responsible for agricultural statistics in the Netherlands and in the early 1860s he also advised the prime-minister, J.R. Thorbecke (1798-1872), on the arrangement of agricultural education. He based his advice on a trip to Belgium, Germany and Denmark, and appeared to be most enthusiastic about the German and Danish agricultural academies that "emanate a sound academic atmosphere".[28] The arrangements for agricultural education dominated the nineteenth century discussion about the way science should be beneficial for agriculture and it was education that was first arranged in 1863. The views and wishes of the agrarian community on this and other matters were primarily expressed by the leaders of the various agricultural organisations. These prominent members, however, were almost without exception members of the wealthy upper layers of the rural and urban communities, many of them with an academic degree.

## Science and agriculture in the Dutch East Indies

The Dutch East Indies became official state property of the Netherlands in 1799. In that year the government of the Batavian Rerpublic took over the administration of the bankrupt United East Indies Company (*Verenigde Oost-Indische Compagnie*, VOC). In the seventeenth century the VOC reigned over a large part of South East Asia, a situation gradually declining in the eighteenth century. The VOC was first of all a trading company, bringing pepper, spices and raw silk to Europe and shipping all sorts of goods between the many islands and countries in the Asian region. Because Asians had little interest in European produce and the Spanish cut off the silver bullion supply to the Netherlands, the Dutch set up a dense network of inter-Asian trading to earn the money for the purchase of goods

[27] Veldink, *W.C.H. Staring 1808-1877*, 49-57.

[28] Staring, *Verslag over de landhuishoudkundige school*, 23.

from the East Indies for the European market.[29] The inter-Asian trade system set up by the Dutch was one of the reasons why they maintained rule over so many islands. When the Dutch government took over, territorial boundaries were more or less set, although the Napoleonic wars resulted in considerable reduction of the Dutch colonial territory, in favour of the British. The VOC had set up its major base at the north-west of the island Java. The place was called Batavia, and it remained the capital of the Dutch East Indies until the Indonesians gained their independence in 1949 and renamed it Jakarta. The VOC, and later the Dutch government, always treated the Dutch East Indies as a trade colony. Settlement of Dutch or other civilians was not encouraged (or even forbidden), unless functional for the trade of the VOC and later the plantations and colonial government services. The VOC had much difficulties finding personal on their ships, as at times only thirty percent of sailors survived the trip to the east. Therefore, the company recruited many sailors from the neighbouring German states. Scientists visited the Indonesian archipelago from the seventeenth century. They were primarily physicians, brought there to take care of the health of the traders and the troops. Charmed by the natural beauty of the islands, they started to investigate and collect plants, animals and stones, attracting other natural historians from the Netherlands and other countries. When the government of the Batavian Republic gained rule over the Dutch East Indies the territory was divided in several Residencies, each headed by a chief official, the Resident. Responsible over the entire colony was a governor-general, seated in Batavia but subordinate to the minister of colonies, seated in The Hague. During the early nineteenth century the British considered the Batavian Republic a vassal of the French empire and took over the colonial territories of the Netherlands, with far the larger part handed back to the Dutch in 1816.[30] One of the first initiatives of the new Dutch rulers was the creation of a Botanic Garden on Java. Besides the exploitation of the natural wealth and indigenous production, the development of the island and its inhabitants became one of the issues of concern. The general idea was to bring enlightenment to the savage population of the islands and humanitarian motives were often expressed, but only as far as economic benefit would not be jeopardised. The change in colonial rule implied new orders for the scientists. They had to assist in the development of agricultural production, mainly by introducing and testing new plant species. The central institution for this work became the Botanic Garden (*'s Lands Plantentuin*) in close cooperation with the colonial administration. Scientists took care of the testing of plants and their survival during transport; the administrators took care of the distribution of new material and knowledge.

[29] Israël, *The Dutch Republic*, 940-946.

[30] Fasseur, "Nederland en Nederlands-Indië", 348-359.

### The Botanic Garden

On 29 October 1815 a number of vessels set sail to Java. The fleet had on board the Commissioners who were assigned to take over authority from the British, arranged by the London Convention of August 1814. The new Dutch supervisors were supposed to continue what the English lieutenant-governor Raffles, and before him the Dutch governor-general Daendels, had started: the modernisation of the Indonesian archipelago, of which Java was far and away the most important island. Daendels launched the modernisation of Java in 1808 with the construction of a road from one end of the island to the other, and by organising a central administration. He divided the island into Residences and linked the Dutch administrators with regional indigenous leaders, the so-called Regents. Raffles continued his work after the British had captured the archipelago, although he did not trust the Regents very much. He connected the European administrators to the leaders of a desa, the local villages, in order to take away 'the barriers which the prejudice of ages have opposed to the administration of justice, and which have paralysed the minds and exertions of the Javanese'.[31] Besides the founding of an administrative system and infrastructure, the colonial rulers were also interested in the natural possessions of the islands and the possibilities to exploit them.

Among the passengers of the fleet that left in 1815 was Casper George Carl Reinwardt (1773-1854), appointed as the new Director of Agriculture, Arts and Science in the colonies. Reinwardt, born in Lützinghausen, Germany in 1773, started his career as a pharmacist apprentice at his brother's pharmacy in Amsterdam where he attended lectures of G. Vrolik at the Athenaeum. After obtaining his doctorate he received a chair at the Academy of Harderwijk and later on in Amsterdam. His task in the colonies consisted of 'observing the bearings of the soil', in order to enrich the Cabinet of Natural History in Amsterdam. Within a year after his arrival Reinwardt proposed to establish a Botanic Garden on Java, which was put into effect on April 1817. A section of the palace garden of the governor-general in Buitenzorg was separated for growing plants and agricultural experimentation under the name of *'s Lands Plantentuin*. Reinwardt was assisted by a draughtsman and two gardeners, one from Holland (Willem Kent), and the other (James Hooper) from Kew, who preferred to remain on Java after a journey with a British botanical delegation. In the five years between his appointment and his return to the Netherlands, Reinwardt travelled around the archipelago and managed to collect several hundred different plants. He was not the only scientist in the Dutch Indies working for the king. In 1820 a *Natuurkundige Commissie voor Nederlandsch-Indië* was created, consisting of two physicists, Van Hasselt and Kuhl, who also started to travel around the archipelago.[32]

[31] Van den Doel, *De stille macht*, 43.

[32] Sirks, *Indisch natuuronderzoek*, 86-140.

Most of Reinwardt's taxonomic work was put down on paper by his successor, Carl Ludwig Blume, another German, who arrived on Java in 1822. Blume published the first catalogue of the Botanic Garden and his arrival also was the occasion the formulate some new regulations. The main objective of the garden was the collection of plants, especially those with remarkable or useful features. Furthermore, exotic plants were to be grown in order to see whether they could be cultivated on Java. Exotic means (in this context) the other islands of the archipelago as well as China, Japan, etc. Plants and seeds had to be ready for sending at any time to the Netherlands or elsewhere.[33] The Garden remained in the hands of Blume for four years, in which time he published the 'Contributions to the flora of the Dutch Indies'. In August 1926 the colonial administration terminated the functions of director and draughtsman of the Botanic Garden and the budget of the garden was slashed. The garden was put under direct command of the Governor-General.

**The Culture System**

The Dutch king was not very satisfied with the financial returns from the Dutch East Indies. Moreover, the Netherlands fought wars with Belgium and sultanates on Java striving for independence. The wars put a heavy financial burden on the Dutch state and the king was forced to change his policy drastically. He appointed a new governor in 1830, Johannes van den Bosch, who had served as an army officer for the VOC in the eighteenth century. The arrival of Van den Bosch on Java announced a period of more than thirty years in which Java was put under a severe system of agricultural exploitation, known as the Culture System (*Cultuurstelsel*), that started in 1830 and lasted until about 1860, to be officially abolished in 1870 by a new agrarian law for the colonies. The main feature of the Culture System was that the colonial administration forced the indigenous population to grow export crops (mainly coffee, sugar and indigo) for which a fixed low price was paid to the benefit of the governmental purse. Contrary to what the name suggests, this Culture System was not very systematic in its functioning, but more a series of local arrangements designed to get production moving.[34] The payment of, for example, the plant wages, the small return the Javanese farmers received for their efforts, was arranged very badly and at will of the local administrators. Moreover, the administrators obtained a bonus depending upon the yield and thus depending on the zeal of the peasants. The administrators were not very well informed about an appropriate amount of export crops that could be grown, or what a relevant rate of land revenue should look like. Attempts by the government to start the immense task of survey and classification of land had to

[33] Ibid. Treub, "Geschiedenis van 's Lands Plantentuin", 20-57.

[34] Fasseur, *Cultuurstelsel en koloniale baten.*

be abandoned for a lack of means and staff, and more or less reliable figures would not become available before the end of the century. The attempts of Raffles and his successor Van der Capellen to take power out of the hands of the regents was reversed by governor Van den Bosch. According to him the Dutch had made the mistake "to measure the social institutions of Java and the wish of the Javanese by those of more civilised Europe and the more enlightened Europeans."[35]

The developments during the Culture System can be characterised as a process of re-feudalisation. But it was not just putting the clock back. The roads that were constructed for the transport of products opened up the inland areas and the payment of plantation wages increased money circulation. Scientific activities at Buitenzorg continued, although the garden had lost its autonomy and most of its budget. Governor Van den Bosch had taken his own gardener, Johannes Elias Teysmann (1808-1882). He was appointed as head of the Botanic Garden in 1830. During the third decade of the nineteenth century the garden hardly developed and was primarily used for testing new plants in terms of value for cultivation.

In 1837, Justus Karl Hasskarl, born in Germany, sent a request to the Governor to appoint him at the Botanic Garden. Hasskarl had tried to make a living out of physics and medicine on Java, but without much success. Although he had his doctorate, he was offered a position as subordinate of Teysmann, which did not keep him from accepting it, and together with Teysmann he started to reorganise the garden and organise all the plants and trees according to their taxonomic order. Teysmann and Hasskarl also managed to secure a piece of land in the mountains. As a gardener, Teysmann was mainly concerned with the preservation and improvement of the gardens. Hasskarl had a scientific interest as well and organised several botanic expeditions in the archipelago in order to expand the plant collection. The tenuous institutional arrangements of the garden brought about attempts by Dutch botanists to take possession of the collection. In 1850 a Leiden professor (W.H. de Vriese) sent Simon Binnendijk to Java to become an assistant of Teysmann. His appointment, however, was not intended as a support for Teysmann's work. Quite the reverse, Binnendijk was sent to Buitenzorg with the task to prepare the shipping of plants to the Hortus of Leiden. Former director of the Buitenzorg garden and by then director of the State Herbarium in Leiden, Carl Blume also made several attempts to get hold of the Buitenzorg collection. Teysmann did his best to frustrate these attempts to plunder the gardens, a task in which he appeared to be quite successful. He even turned Binnendijk into a devoted assistant and they went on gathering plant material from the archipelago and receiving plants and seeds from many other places.

[35] Van den Doel, *De stille macht*, 58.

The function of the garden for colonial agriculture did not change much with the introduction of the Culture System. Plants were tested and when different varieties of a species were available, some comparisons were made. Possible spread of new plants depended much on the cooperation of the European and local administrators. The farmers had some possibilities to modify and evade the impositions of the colonial administration, mainly because of the lack of detailed insight in the area of cultivated land and practices of Javanese agriculture.

### Cinchona and chemistry

Although the garden in Buitenzorg mainly focused on Indonesian plants, several contacts were arranged with the botanic gardens from New-Holland, Ceylon, Calcutta, Cape Hope etc. As most botanic gardens, *'s Lands Plantentuin* primarily functioned as a centre for the storage and distribution of seeds, cuttings and plants from all over the world. During the 1830s and 1840s no serious attempts were made to import exotic plants for the expansion of the number of crops grown on Java. This changed in the 1850s when Hasskarl was sent to South America in order to obtain seedlings of the cinchona tree (*Cinchona spp.*). Quinine, extracted from the bark of the tree, was the only defence against malaria until the Second World War. Quinine kept colonial administrators and soldiers alive, which is rather important for ruling a colony. The bark was mostly collected from wild trees, growing in the Andes region and was of an unpredictable quality, not the least because several species of the tree were used (but primarily *Cinchona condaminea*). Moreover, it was feared that cinchona supplies would run out with the cutting of the wild trees which was enough reason to obtain living cinchonas and reproduce them in the colonies. After his expedition to South America Hasskarl became the first director of the Government Cinchona Company. The species Hasskarl came back with turned out to be hardly productive, but a few years later, Franz Wilhelm Junghuhn, a naturalist attached to the Natuurkundige Commissie and successor of Hasskarl at the Cinchona Company, managed to obtain better species (*Cinchona pahudania*).[36]

The cinchona story is interesting not only for its contribution to colonisation and imperialism, but also because it shows how chemistry and tropical agriculture were connected. The relation between chemistry and botany as such is not exceptional. Checking plants for their chemical substances and medical potentiality was a regular habit of both naturalists and chemists. Reinwardt, the founder of the botanic Garden, had worked as a pharmacist apprentice and was most certainly acquainted with the chemical possibilities of many plants. There had been a botanic garden on Java already in the eighteenth century, primarily for

[36] Brockway, *Science and colonial expansion*, *103-139*. Headrick, *The tentacles of progress*, 231-237.

medical reasons.[37] Moreover, analyses on sugar cane were quite regular in the nineteenth century in order to obtain cultivars or species with a higher sugar content. Liebig's publications in the 1840s had boosted organic chemistry worldwide. What was new about quinine production in the Dutch East Indies was the form in which the colonial governmental had organised it. The cinchona tree was not introduced on Java with the intention to leave cultivation to the indigenous farmers, voluntarily or imposed, but it was set up as a plantation. These cinchona plantations, however, were not supervised by colonial administrators but managed by scientists.

In 1848 Pieter Frederik Hendrik Fromberg (1811-1858) was appointed as Agricultural Chemist of the colonial goovernment. His teacher, the Utrecht chemistry professor, Gerrit Jan Mulder, had persuaded the Dutch government to create such a post. Fromberg, who had worked as an assistant of J.F.W. Johnston in Edinburgh, was highly recommended by Mulder and in 1851 he created an agricultural-chemical laboratory at Buitenzorg where mainly soils and organic fertiliser were analysed.[38] He was also engaged in the analysis of alkaloids in plants with the objective of finding a substitute for quinine. The agricultural-chemical laboratory was not very successful and closed down in 1860, two years after Fromberg's death. Meanwhile, Junghuhn had persuaded the governor to appoint a chemist for research on cinchona bark. Mulder again recommended one of his students, Karel Wessel van Gorkom, who arrived on Java in 1857, but Junghuhn preferred the assistance of Johan Eliza de Vrij, a former lecturer of the Clinical School in Rotterdam. For Van Gorkom there remained nothing than to travel around and do some provisional work at the laboratory of Fromberg. He succeeded Junghuhn after his death in 1864 and led the Government Cinchona Company during its most successful years. In 1875 he was appointed as Chief-Inspector for the cultivation of sugar and rice. In 1880 he returned to the Netherlands where he published a book about the cultures of the East-Indies and started to give lectures in Colonial Agriculture at the State Agricultural School in Wageningen.

### Experimental botany

The turn in colonial policy in the 1860s improved the political climate for the Botanic Garden. Teysmann appeared to be highly dedicated to his work and the advancement of the Botanic Garden. He had requested the governor several times to rehabilitate the Botanic Garden as an independent scientific institution. A very valuable contact for Teysmann appeared to be F.A.W. Miquel. Miquel had

[37] Florijn, "Geschiedenis van de eerste hortus medicus in Indië", 209-221.

[38] Snelders, "Gerrit Jan Mulders bemoeienissen", 253-264. Rossiter, *The emergence of agricultural science*, 95-108.

studied medicine and physics in Groningen and became professor at the University of Utrecht in 1859. He was an internationally appreciated botanist and member of the Swedish Academy.[39] Miquel received much plant material from Teysmann and as a favour in return Miquel put pressure on the Minister of Colonies to appoint a 'scientifically trained botanist' at the Botanic Garden. In 1868 this was effectuated when Rudolph Herman Christiaan Carel Scheffer (1844-1880), recommended by Miquel, became the new director of the Botanic Garden. Scheffer had studied medicine and physics at Utrecht University and received his doctorate in March 1867. In November of the same year he set sail for Java, on the way visiting the botanic garden of Peradenya in Ceylon. With the arrival of Scheffer the Botanic Garden regained its organisational independence. Teysmann was honourably discharged from his tasks as gardener in 1869 and asked to organise botanical expeditions. Under Scheffer's authority activities at Buitenzorg gradually increased. New buildings were constructed and some extra personnel appointed. In 1876 a piece of land was attached, several kilometres outside Buitenzorg, called Tjikeumeuh, on which mainly culture crops like jute, maize, peanut, soy and rice were grown and tested. In the same year an agricultural school was opened where sons of the native elite and Dutch administrators were instructed. It was also in 1876 that the first issue of a journal was published, *the Annales du Jardin Botanique de Buitenzorg*. Scheffer was a young and energetic botanist who worked for 12 years on Java. He was the first scientific director of the Botanic Garden since Blume left Java in 1826, but would be the last in a tradition.

As a student of Miquel, Scheffer was educated in the structural taxonomic tradition in botany. The taxonomists primarily concentrated on exterior features of plants which determined the plant's position in the natural order. This conception was seriously challenged by Darwin's *Origin of species* that emphasised evolution and descent of plants and animals. In view of the Darwinistic biology, physiological characteristics and hereditary issues became of prime interest. The reception of Darwinian ideas in academic botany in the Netherlands came relatively late. The botany professors of the different universities did not interfere in discussions about Darwinistic theory and it was not until 1871 that the first chair was created in which plant physiology was an explicit assignment. When Scheffer died in 1880 he was succeeded by Melchior Treub (1851-1910). Treub had studied in Leiden, where W.F.R. Suringar was professor in botany. Suringar was a classical taxonomist as well, but Treub was a fellow student of M.W. Beijerink, H. de Vries and J.H. van 't Hof, who discussed Darwinian biology in their student associations. In the last two decades of the nineteenth century, all these men would acquire key positions in scientific institutions in the Netherlands and its colonies and therewith advanced plant physiology and genetics.[40] This shift in focus did not imply that taxonomy was

[39] Sirks, *Indische natuuronderzoek*, 187-189.

[40] Hagendijk, *Wetenschap, constructivisme en cultuur*, 169-173.

out of scope. Taxonomic studies had lost their dominance, but remained important, especially in the Indonesian archipelago where many species and varieties still waited for classification. In his history of the Botanic Garden, Treub repeatedly emphasised that the main scientific value of the Botanic Garden is that its plants and trees are arranged according to taxonomic order.[41] But the interest of Treub and his fellow biologist in plant physiology and genetics would initiate new directions in the research at the Botanic Garden and ultimately lead to the founding of a Department of Agriculture in the Dutch East Indies.

### Rice and food policy

The organisation of quinine production can be considered as just another interference by the colonial government, roughly resembling other interventions in the Culture System. But the culture of cinchona was the first form of colonial agricultural production in which the government organised, monitored and controlled the cultivation process by means of experts; in the first years by the naturalists Hasskarl and Junghuhn and later by the chemist and naturalist Van Gorkom. The botanical and chemical experiments the scientists conducted on crops grown by the Javanese had little effect on the cultivation practice of these crops. Most improvements accomplished were related to post-harvest processes and even when new varieties were introduced, or when new cultivation methods were recommended, this was always effectuated by the colonial administrators by means of regulations. There was no direct interference with farming practice at the field level.[42]

Rice production did not differ much in this respect. In the 1820s colonial administrators had tried to commercialise rice production on Java by setting up rice milling enterprises. The colonial government itself owned a rice mill, called Molenvliet, but this did not turn out to be a very profitable business and the mill was closed down in 1845. The main reason was that the supply of paddy for the mills was insufficient. The inland rice market was primarily controlled by Chinese traders, who also served as the chief moneylenders to Javanese peasants. Traders and administrators could not influence the village policy to such extent as to guarantee a stable delivery nor were rice producers and local traders convinced of the advantages of large scale commercialisation.[43] The failure in making rice an export crop implied the end of government interest in rice production. Rice production, however, played a role in colonial rule because it formed the base of taxation of the indigenous population through the land-rent system.

[41] Treub, *De betekenis van tropsiche botanische tuinen.*

[42] Fasseur, *De indologen*, 131-135.

[43] Hugenholtz, "Famine and food supply in Java", 155-188.

The imposed cultivation of export crops and the labour the Javanese peasants were forced to provide during the years of the Culture System had its effect on the production of food crops. Most clearly was this the case with sugar production. Sugar cane needs a lot of irrigation water, was mostly grown on *sawahs* and therefore was a direct competitor of rice. The Culture System and the inadequate control of the food market resulted in several severe famines in different regions of Java during the 1840s. The colonial government reacted on those famines with massive purchases of paddy from abroad, but the lack of influence on local rice trade made it not a very effective relief measure. From the late 1850s criticism rose on the Culture System. Especially the abuse of the Dutch administrators and local leaders was disapproved. The government reluctantly responded to the criticism with several new administrative regulations and instructions in order to prevent the worst abuses. The Culture System was abolished by the liberal government headed by Thorbecke, formal abolishment coming in 1870 with a new agrarian law for the Dutch East Indies. The new course of colonial rule implied more attention for the wealth of the indigenous population, a wealth largely dependent on the ability to feed itself. During the last three decades of the nineteenth century the food situation and agriculture in general were in a rather critical position. The coffee blight and several cane diseases affected the cultivation of export crops. The agrarian crisis of the 1880s resulted in low prices for the crops, something also affecting the many Javanese working on the plantations. Moreover, several crop failures caused famines, most severely in the middle part of Java in 1900. In 1901 and 1902 the government spent over 1,5 million guilders on relief programmes.[44] The famine was accompanied by the outbreak of a cholera epidemic and the government decided to install a special commission to investigate the causes of the famine in the Semarang Residency. Establishing an examining commission after a famine was as such not very new and the final conclusions were in most cases predictable. Regarding the causes of the famine, the Semarang Commission mentioned 'disasters beyond human control and unforeseen circumstances' which was in line with the tradition and mainly expressed the inadequacy of the colonial administration regarding these matters. But for the commission the case was not closed with that. "The greatest impediment to a structural improvement of the situation in general, according to the commission, was the government principle which prescribed that the Javanese peasant ought to be seen as someone well able to understand his own interests and who should be given complete freedom in agricultural matters."[45]

The conclusion of the commission announced the end of a liberal period. The same liberal view that relieved the Javanese farmers from the burden of the Culture System appeared not to have a general boosting effect on the indigenous

[44] Ibid.

[45] Ibid., 178.

agricultural production. Towards the end of the nineteenth century the idea gained ground that the colonial government should take up a more active role in the stimulation of food production. The colonial government indeed showed an increasing interest for the welfare of the Javanese, bearing considerable consequences for the organisation of agricultural research. During his directorship of the Botanic Garden, Treub became more and more involved in the improvement of plantation agriculture, resulting in a growing body of knowledge and experience over agricultural production. In 1905 the colonial government and Treub joined forces through the creation of a colonial Department of Agriculture.

## Conclusion

The three main elements of modern agricultural science, state interest, experimental research and the expressed demands of the agrarian sector were combined in the nineteenth century in the Netherlands as well as in the Dutch East Indies. The development spanned almost the entire century. The first government initiative to create facilities for a scientific approach to agriculture was established in the Netherlands in 1815 with the creation of university chairs in land-household studies. A year later the colonial government created a Botanic Garden on Java, being a scientific institute also aimed at the improvement of agriculture. The Botanic Garden can be considered as most successful in that respect, although it focused on crops primarily of interest for the European colonisers. The university chairs in land-household studies were far less successful in their impact on Dutch agriculture. The envisioned linkage between the lectures and farming practise via preachers was not accepted by the church and farmers showed up at the lectures only in Groningen. The change from a scientific approach to agriculture that was merely descriptive to an experimental approach took place in the years the university chairs in land-household studies and also the Botanic Garden were facing difficulties. From about the 1860s the government interest in agriculture in the Netherlands and the Dutch East Indies gradually increased. In the colonies the rulers realised that a flourishing and well-nourished indigenous population implied political stability, a healthy indigenous labour force and increasing tax returns. In the Netherlands similar motives made the government decide to invest in agricultural education and experimentation with the creation of a State Agricultural School and a State Agricultural Experiment Station where science and agriculture were combined. Further investments in the colonies came in the 1890s and a decade later the colonial government created a Department of Agriculture where scientific research was performed for agriculture. Although the overall structure of agricultural science was established around the turn of the century, the details of its organisation and implementation were far from settled.

# 3

# The organisation of agricultural research

## Introduction

The emergence of agricultural science in the Netherlands and its colonies implied the addition of an extra branch to the Dutch tree of science. The reception of the new facilities for agricultural science by the existing education and research institutes differed from great enthusiasm to clear scepticism. Clearly, agricultural science was different from other forms of science. The most common distinction was between pure or fundamental science on the one hand and applied science on the other. Almost every scientist, including agricultural scientists, agreed that the latter category also embraced the agricultural sciences. In this chapter it will be shown that the agreement more or less stopped at that point. What exactly the distinction implied, who was capable and competent for either forms of science and how the two should relate in organisational terms was all subject to discussion. Especially during the first two decades of the twentieth century the debates were rather heated. In that period the organisation of agricultural science went through a crucial period and not every academic was very happy with the chosen format. Agricultural science embraces research and education, and although the two elements are connected in many ways, the analysis of research and education is divided over two chapters. Education is the subject of the next chapter and in the following pages the development of agricultural research is examined. Central are the ideas, accusations, defences and plans formulated for agricultural research and how it should be organised. To avoid any disappointment it should be said that the idea of this chapter is not to settle the hash once and for all about the distinction between pure and applied science. The variety of interpretation of the categories and the effect of these interpretations for the organisation of agricultural research are far more interesting and important than the essence of the categories as such.

The story begins with an examination of the roots of agricultural research. From the 1840s private agricultural societies and farmer organisations in the Netherlands looked for ways to make research beneficial for agriculture. Contrary to the situation in most neighbouring countries the private agricultural organisations did not manage to set up experiment stations themselves and fully relied on government initiative. The government took the initiative at the end of the nineteenth century and what this comprised is described in the first section. The second section covers the organisation of agricultural research in the Dutch East Indies. Contrary to the situation in the Netherlands, private planter organisations created research stations. Although the developments in private research are not entirely out of scope, the emphasis in the section is on the efforts of the colonial government regarding agricultural research. The debate about what agricultural science is and how it should be organised was debated fiercely in the colonial context. The debate comes back in the third section when the developments in agricultural research in the Netherlands are picked up from the 1920s onward. The chapter ends with some concluding remarks.

## Agricultural research in the Netherlands, 1870s-1920s

The idea to set up stations for agricultural research first arose in the Netherlands in the 1840s. The plans were indirectly a result of the work of the German chemist Justus von Liebig (1803-1873) who worked on a theory of organic chemistry in those years. His ideas opened new paths for research and experimentation with organic and artificial fertilisers and his publications spread all over the world. Consequently, new laboratories and experiment stations were created, funded by farmer associations as well as local governments, where chemical analyses and experiments were conducted.[1] In the Netherlands the idea for chemical research for agriculture was launched in the annual meetings of the regional agricultural organisations and societies, Land-household studies Congress (*Landhuishoudkundig Congres*). This congress was, besides a public exhibition, an opportunity for the boards of the provincial agricultural societies to meet and discuss the future of Dutch agriculture. Special commissions were assigned to report on certain issues, maintaining continuity over the years. The first congress was held in 1846 in Zwolle and resulted in a commission for chemistry that reported the following year in Arnhem. It proposed to extend education in chemistry and to open up existing university laboratories for analyses of agricultural products. A regular visitor to the congresses was G.J. Mulder (1802-1880), professor in chemistry at the University of Utrecht, and he commented on the proposal by stressing that the laboratories in the Netherlands were primarily set up for education purposes, although he considered the idea of chemical analyses at a charge certainly possible.[2] The charge he mentioned hit a sore spot, because the large majority of Dutch farmers had not enough financial resources to pay for chemical analyses. The idea was never realised, but the issue kept reappearing on the agenda of the congress and always two arguments were given. One was improvement of soil fertility through experimentation with chemical fertilisers. The other was control of fraud and forgery over agriculture inputs like fertiliser, cattle cake and seeds. Finally in the 1860s the issue was taken up in the plans to create a school for scientific education in agriculture. In 1876 such a school was opened, the State Agricultural School (*Rijkslandbouwschool*) located in Wageningen, and in February 1877 a State Agricultural Experiment Station (*Rijkslandbouwproefstation*) was attached to the school. The head of the station, the German chemist A. Mayer (1843-1942), also provided courses in chemistry at the school. The State Agricultural School issued a booklet every year, containing the programme of education and a report covering the preceding year of the school and the experiment station. In the first five months of its existence the station analysed 81 seed samples, 31 samples of fertiliser, 11 feed samples, 19 soil samples and 4 dairy products. "Besides, there were, related to

[1] Snelders, "Landbouw en scheikunde", 72-79. Rossiter, *The emergence of agricultural science.*

[2] *Verslagen Landhuishoudkundig Congres*, 1847. Snelders, "Landbouw en Scheikunde", 86-101.

experiments for the improvement of land inundated by seawater, many salt determinations in different soils and some members of the Experiment Station were involved in other, more scientific activities."[3] The samples primarily came from private firms that sold seeds, fertiliser, cattle feed and other farm inputs and the station charged these companies for the analyses. In return the station provided the firms with a certificate with the test results, used by most companies to recommend their products.

## Crisis and expansion

Between roughly 1880 and 1900 a severe economic crisis struck the agrarian sector in the Netherlands. The crisis was a culmination of various developments, minimising the prices of many agricultural products. One of these developments was the construction of large ocean steamers, facilitating bulk transport of cereals from the Americas to Europe. In some cases, like madder, the cultivation of the crop was almost wiped out as synthetic dye replaced the product.[4] The crisis was severe enough to install a state commission in 1866 that had to formulate improvements for the agrarian sector. Chairman of the commission was Cornelis J. Sickesz (1839-1904), estate holder and president of a provincial agricultural society, the *Gelderse Maatschappij van Landbouw.* The vice-president and official reporter of the commission was P.W.A. Cort van der Linden (1846-1935), economy professor at the university of Groningen.[5] Although several farmer organisations pleaded for protective economic measures the majority of the commission members favoured a liberal policy, meaning no economic barriers and only general regulations and support measures. Consequently, most of the proposed measures promoted public investments in technological innovation.

[3] *Programma van het onderwijs* (1877-1878), 43.

[4] Van Zanden, *Transformation of European Agriculture*, 107-157.

[5] Vermeulen, *Den Haag en de landbouw*, 44.

**Table 1: Measures proposed by the State Commission for Agriculture of 1886. (Source: Landbouwcommissie, *Verzameling van adviezen.*)**

- Control of butter trade
- State support for agricultural schools
- Creation of State Experiment Stations
- Control over import of livestock
- Better credit facilities for farmers
- Arrangements for agricultural education
- Improvement of the national horse breed
- Organisation of farmer representation
- Community reports on agriculture and annual report on agriculture
- Tax measures favouring agriculture
- Arrangements on tenure and land use

The recommendations of the commission covered quality supervision, fraud control, research and education. Regarding education the commission advised the government to act only where private initiative failed or did not suffice. Lower-level agricultural schools, for example, should be subsidised to a maximum of fifty percent. The initiative for creating such schools should come from local organisations. "Only those, who are well familiar with local circumstances, with the nature of farming in a certain area, will be able to call into being arrangements that fill the real needs."[6] A proposal covering control and research was the creation of three more experiment stations. State interference on this level was considered necessary for two reasons. First of all because a farmer, "the man who likes to arrange his farm as well as possible, who is well informed, does not even know, cannot know, what aid science can offer him."[7] Therefore, the commission argued, a research station would never come out of private initiative. A second argument – reliability - was formulated along the same line. "If that is left to private initiative, without State interference, there will be no absolute certainty of objective research."[8] The commission further supported its proposal with an overview of the rapidly increasing amount of analyses conducted at the existing Experiment Station in Wageningen. The new stations should be located in different regions and cover the major agricultural activity in the area. One in the west where dairy farming dominated, one in the north focusing on arable farming, and a similar one in the south. The Wageningen station was viewed to becoming a central station, doing research of a general nature as well as serving the provinces Gelderland and

[6] Landbouwcommissie, *Verzameling van adviezen*, 11.

[7] Ibid., 14.

[8] Ibid.

Overijsel. "Moreover, this station will be assigned with the important task to decide on appeal in case conflicts over analyses arise at other stations."[9] In 1890 these new stations were opened in the cities of Hoorn, Groningen and Breda. Two years later the Wageningen station was organisationally disconnected from the school.

A third major innovation the commission proposed was the office of agricultural teachers *(landbouwleraren)*. These were not ordinary schoolteachers but regional supervisors of agricultural education with several other tasks like field experiments, demonstrations and public lectures. The main task however was inspection of agricultural education, with the idea to improve its quality. "Therefore it is clear, how indispensable these officials are, how they form the connection between the different elements of agricultural education and the central government."[10] In 1890 the first of these teachers was appointed for the provinces Gelderland and Overrijsel, soon followed by other appointments covering the other provinces. Besides agricultural teachers employed by the government, the provincial agricultural societies appointed similar advisors, subsidised by the government, called agricultural consultants, *landbouwconsulent.* On the national level two new offices were created. In 1892 the inspection for agricultural education was taken out of the general school inspection and F.B. Löhnis (1851-1927) was appointed as national Inspector for Agricultural Education, including the leadership over the agricultural teachers and consultants, together forming the Agricultural Extension Service, *Landbouwvoorlichtingsdienst.*[11] The other new element in the government administration was the division Agriculture (*afdeling Landbouw)* at the Ministry of the Interior in 1897. The division was headed by a Director-General, the former chairman of the state commission for agriculture, C.J. Sickesz[12] In 1901 the division moved to the Ministry of Industries and Trade, renamed in 1905 as Ministry of Agriculture, Industries and Trade, and the new Director-General in that year was H.J. Lovink (1866-1938). In the same reorganisation an extra inspector was added. F.B. Löhnis moved to the office of Inspector of Agriculture and P. van Hoek (1865-1926) became Inspector of Agricultural Education, but Löhnis remained responsible for the Extension Service. In 1906 the division Agriculture received the status of a directorate, *Directie van Landbouw*, implying more autonomy in relation to other ministerial branches.[13] The crucial element in these changes is the move from the inspection for agricultural education. The inspector had to uphold the legal provisions regarding agricultural education, including the State Agricultural School *(Rijkslandbouwschool)* in Wageningen. The Ministry of the Interior maintained responsibility of all the non-

[9] Ibid., 20.

[10] Ibid., 54.

[11] Zuurbier, *Besturing en organisatie*, 30-32. Goudswaard, *Agrarisch onderwijs*, 170-171.

[12] Zuidema, "Sickesz (Cornelis) Jacob)."

[13] Directie van den Landbouw, *Een en ander*, 1-11. Vermeulen, *Den Haag en landbouw*, 64-80. Zuurbier, *Besturing en organisatie*, 32.

agricultural elements of the education system. In short, the Directorate of Agriculture supervised all government affairs regarding agriculture.

**Control stations and research stations**

In 1898 a fifth experiment station was opened in Maastricht and in 1899 the Wageningen station was split into a general experiment station and a State Agricultural Experiment Station for Seed Control (*Rijkslandbouwproefstation voor Zaadcontrole*).[14] The mandate of the experiment stations, formulated in 1892 was first to examine soil, water, fertilisers, feed, seeds and other materials on request of the government, individuals or other agencies. The second task was performing agronomic and fertiliser experiments on plots made available by government, individual or other agencies and, thirdly, performing scientific research of a more general nature regarding agriculture.[15] The number of samples analysed by the research stations increased rapidly. In 1891 the experiment stations together examined about 2000 samples. Over the years 1891-1901 the annual growth was about 500 samples but over the years 1901-1911 the growth rate was already 1700 samples a year. In 1913 a total of about 28,500 samples of fertiliser and feed were examined.[16] At the turn of the century the directors of the stations complained that it was hardly possible to do any other experimental work and asked Lovink to take action.

In 1907 the organisational set-up of the stations was changed. "The essence of this reorganisation was that every station would realise a split in different divisions with its own staff, in which the agronomic research and the control activities would be strictly separated."[17] The measure appeared to have little effect and already in 1908 Lovink sent D.J. Hissink, director of the Wageningen station, to Germany to find out how things were arranged there. In his report Hissink explained that in Germany some stations worked in a similar way to the Netherlands but in some cases, like in Halle, the research and control tasks were allocated to two different stations. Hissink advised Lovink to follow the example of Halle and differentiate between control stations and research stations.[18] The report was submitted in autumn 1909 and in that period Lovink exchanged his position of DG of the Directorate of Agriculture in the Netherlands for the same office at the Department of Agriculture in the Dutch East Indies. It took a while before the new DG, former Inspector of Agricultural Education P. van Hoek, put the issue on the agenda, but in September 1915 new regulations for the agricultural experiment stations were

[14] Maltha, *Honderd jaar landbouwkundig onderzoek*, 105-112.

[15] Hissink, "Reorganisatie van het proefstationswezen", 9.

[16] Ibid., 13-14.

[17] Ibid.,13.

[18] Ibid., 15-18.

enacted, following the advise of Hissink. The stations were split up in four control stations, Maastricht, concentrating on fertiliser, Goes, where the Breda station had moved to in 1893, concentrating on various materials (closed in 1922), and two stations in Wageningen, one for seed and one for feed analyses. The remaining stations became research stations, the one in Groningen for arable crops and pastures, the one in Hoorn for dairy products and feed.[19] The division in tasks between the stations remained more or less intact until the late 1930s.

**Table 2: Agricultural research institutes in 1930. (Source: *Programma van het onderwijs*. Maltha, *Honderd jaar landbouwkundig onderzoek*.)**

| **Laboratories at the Agricultural College** | | **Institutes attached to the Agr. College** | **Experiment Stations** |
|---|---|---|---|
| 1. Agricultural chemistry | 12. Entomology | 1. Agricultural machinery | 1. Groningen |
| | 13. Taxonomy | 2. Phytopathology | 2. Hoorn |
| 2. Chemistry | 14. Plant physiology | 3. Plant breeding | 3. Maastricht |
| 3. Botany | 15. Microbiology | | 4. Wageningen |
| 4. Arable crops | 16. Geodesy | Other institutes | |
| 5. Tropical agriculture | 17. Genetics Diary products | 1. Bulb research | |
| 6. Zoology | 18. Horticulture | 2. Poultry | |
| 7. Physics | 19. Mycology & potato research | 3. Soil research | |
| 8. Mineralogy & geology | 20. Technology | 4. Sugar beet research (private) | |
| 9. Civil engineering | 21. Bulb research | | |
| 10. Cattle breeding | | | |
| 11. Agricultural mechanics | | | |

Meanwhile, the Extension Service rapidly expanded too. Between 1905 and 1915 the service grew from about 25 to 35 advisors and they ran about 700 experiment fields in 1905.[20] The changes in the government services and growth of research and extension activities affected the position of the State Agricultural School in Wageningen. Under guidance of Lovink and van Hoek the several branches of the school were split up. The *Rijkslandbouwschool* contained since its origin a division for middle-level and a division for scientific agricultural education. Moreover, it included a three-year secondary school, the *Hogere Burgerschool* (HBS), required for admission to one of the agricultural divisions. In 1904 the secondary school was

[19] Ibid., 25-36. Maltha, *Honderd jaar landbouwkundig onderzoek*, 103-113. Directie van den Landbouw, *Gedenkboek Rijkslandbouwproefstation*, 9-13, 22-26.

[20] Directie van den Landbouw, *Een en ander*, 70-71. Zuurbier, *Besturing en organisatie*, 33-34.

split off and modified in a more common five-year HBS. The two levels of agricultural education were separated and the lower level was renamed the State Agricultural School, (*Rijkslandbouwschool*) and the scientific division State Higher School for Agriculture, Horticulture and Forestry (*Rijks Hogere Land-, Tuin-, en Bosbouwschool*). In 1912 the State Agricultural School was split into a school for colonial agriculture that moved to Deventer and a school for Dutch agriculture that moved to Groningen. In short, the Wageningen education facilities were filtered out, leaving one school for scientific agricultural education. The school was included in the system of higher education in 1918 and changed its name in Agricultural College (*Landbouwhogeschool*).[21] This process included a new mandate for the school. Instead of offering scientific education to the agrarian population it primarily aimed at the formation of scientific experts in agriculture, horticulture and forestry to be employed in the various services and institutes.

**Experiment stations and research institutes**

In the 1915 reorganisation of the experiment stations the two Wageningen stations were given a control assignment. Compared with the 1892 arrangements this implied a loss of research tasks as well as a loss of the status to act as a court of appeal for the analyses. From that perspective the reorganisation of 1915 implied a loss of the scientific status of the Wageningen research facilities. Such an interpretation however was rejected by Hissink. "It is good to point here at a misconception, being that the implemented reorganisation does not intend to be a division between scientific research and control activities, but between agricultural research and control research."[22]

In the first years of the twentieth century a new type of research centres emerged at the school in Wageningen. From the origin of the State Agricultural School in 1876, the only teacher with an explicit research task was A. Mayer in his function as head of the experiment station. Nevertheless, several other teachers set up experiments, using the teaching facilities of the school. The *Rijkslandbouwschool* owned several pieces of land in Wageningen and the first director of the school, C.J.M. Jongkindt Coninck (1834-1885), put much effort into the creation of a model farm, the *Duivendaalhoeve*, opened in 1880. The second lecturer to become involved in the leadership of a research institute was J. Ritzema Bos (1850-1928). Ritzema Bos was a biologists specialised in pests and diseases of agricultural crops. In 1895 he was appointed as director of the Phytopathology Laboratory in Amsterdam, set up on the initiative of Hugo de Vries (1848-1935), professor in biology at the University of Amsterdam. The laboratory was financed with private funds and functioned independently of the Directorate of Agriculture. Soon, however,

[21] Van der Haar, *Geschiedenis I*, 96-130. See also chapter 4.

[22] Hissink, "Reorganisatie van het proefstationswezen", 23.

the government considered the control of pest and diseases a state affair and in 1899 a Phytopathology Service was created, housed in the Amsterdam laboratory and headed by Ritzema Bos. In 1906 the service moved to Wageningen where in the same year the government created its own Phytopathology Institute. Ritzema Bos resigned from his directorship of the Amsterdam laboratory and headed both the Service and the Institute in Wageningen where he also continued to fulfil his teaching obligations.[23] A year before the establishment of the Phytopathology Institute an Institute of Agricultural Mechanics was set up, directed by another Wageningen lecturer, S. Lako.

In 1912 a third research institute was attached to the school in Wageningen. From the 1880s the teacher in general agronomy, J.O.F. (Otto) Pitsch (1842-1939), together with M.W. Beijerinck (1851-1931) and L. Broekema (1850-1936) were active in the field of genetics and plant breeding. Early twentieth century agricultural societies urged the government to create an Institute for Plant Breeding, and in 1912 such institute was opened in Wageningen, directed by Otto Pitsch.[24] Sharing facilities for education and research was more or less formalised in 1918 when the school in Wageningen officially received academic status and was renamed in *Landbouwhogeschool*. All lecturers received a professorship and part of that status was the availability of a laboratory for research. A laboratory could mean a separate building with several rooms generously equipped, or a small room with little equipment in a shared building. The result of this development was that the Wageningen institution had two organisational formats for research - institutes and laboratories - respectively three and twenty-two in number, by 1930.[25] The difference between an institute and a laboratory was that the first had an explicit assignment to set up research with direct ties to agricultural practice. This was reason for the Wageningen professor in plant physiology, A.H. Blaauw (1882-1942), to criticise the organisation of agricultural research and to come up with an alternative proposal. Blaauw considered the research institutes as an awkward mixture of laboratory and experiment station and in fact proposed to get rid of the concept. "At an establishment for higher education professors cannot fulfil appropriately the requirements practice rightfully demands of an experiment station raised in its interest. (...) Accepting a clear and desired distinction between the professor and his laboratory, his teaching of students, and further his freely chosen examinations that might be of interest for agricultural science, and (on the other hand) the Experiment and Control-stations, inspection services etc., with their directors, aimed at the interests, questions and examinations generated by practice, then we have to look only for a safeguard of sufficient contact between certain professors with their

[23] Maltha, *Honderd jaar landbouwkundig onderzoek*, 60-64. Blink, *Prof. Dr. J. Ritzema Bos, de grondlegger der phytopathology in Nederland*, 561-570.

[24] See chapter 5.

[25] *Programma van het onderwijs*, 1930.

students and this work for practice."[26] The safeguard, as Blaauw saw it, was a commission for recommendation and consultation that should advise where research could best be conducted, at an experiment station or in a laboratory of the Agricultural College. This would also prevent research being done twice in different institutes.

Blaauw was not the only Wageningen professor to express his ideas over the organisation of agricultural research. In the 1920s and 1930s the discussion how to organise agricultural research continued and various proposals were made. Some of the ideas will return later on in this chapter. What can be concluded for now is that agricultural research was divided between various organisational formats - experiment stations, control stations, institutes and laboratories. In each of these formats the relation between science and agriculture was arranged in a specific way. Crucial in the debate was always the question who can determine or influence what kind of research is done. That was also the central question in the organisation of agricultural research in the Dutch East Indies. In the colonies the issue resulted in heated discussions.

## Agricultural research on Java, 1870s-1940s

The origin of agricultural research and extension in the Netherlands, as well in its main colonial territory, was a combined effort of government and private initiative. But the way the combination was made in the Netherlands is very different from the linkage between colonial government and private initiative on Java. Although much of the development in the colonies reflected changes and initiatives in the mother country, the establishment of agricultural research in the colonies has many structural differences and peculiarities that make a special story. First of all, the government involvement was arranged minimally both in the Netherlands and the colonies and mainly depended on the enthusiasm of some university trained and amateur botanists. The official institute on Java that was assigned the task of improvement of agriculture was the Botanic Garden (*'s Lands Plantentuin*) in Buitenzorg. The garden was laid out in 1817 and for nine years it was headed by two Germans, C.G.C. Reinwardt (1773-1854) and C.L Blume (1792-1862). Between 1830 and 1868 the budget of the garden was minimised. The plants and trees were maintained by a gardener, J.E. Teysman (1808-1882), who turned out to be an enthusiast for botany, attracting several university botanists who stayed for a period, using the facilities of the garden.[27] In 1848 a chemical laboratory was build in Buitenzorg as well. The colonial government constructed the laboratory on advice of

[26] Blaauw, Over *organisatorische verbetering*, 19-20.

[27] Went and Went, "A short history of general botany", 390-392. Sirks, *Indisch natuuronderzoek*, 183-215.

the Utrecht chemist G.J. Mulder, and a student of his, P.F.H. Fromberg (1811-1858) was appointed as director of the lab.[28] In 1868 the colonial government made new investments in the Botanic Garden. A scientific director, H.C.C. Scheffer (1844-1880), was appointed, new buildings were constructed and the area of the garden increased. Scheffer, who received his doctorate in medicine, was a classical botanists, meaning that his main interest was to assemble as many species as possible and study their performance in the Buitenzorg climate. The contribution of the Botanic Garden to agriculture, therefore, primarily consisted of the introduction of new species and sub-species.

In 1870 a new law for colonial agriculture was passed by the Dutch parliament. The law abolished the forced delivery of agricultural products by the indigenous farmers to government-led exploitation firms and introduced a system of hiring out land to private planters. Tenancy lasted up to seventy-five years, making long-term investments attractive. Before 1870 private-owned plantation agriculture was not uncommon but the new law boosted plantation agriculture. The planters, especially those in sugarcane, experienced quite some adversity in the 1880s when both the international agrarian crisis as well as a cane disease threatened their livelihood. The cane planters recognised they could only survive when they joined forces and organised several associations to find ways out of the crisis. Scientific investigations were considered necessary, to improve the crop, control diseases and make sugar extraction more efficient.[29] In 1886 and 1887 three experiment stations for sugarcane were created, divided over the western, middle and eastern part of Java. One station was closed after a few years and the other two merged in 1907. In 1896 the board of the West Java Experiment Station submitted a request to the government for financial support. The request was passed on to the director of the Botanic Garden, Scheffer's successor Melchior Treub (1851-1910) who advised to grant the application on the condition that the colonial government (meaning Treub himself) controlled staff appointments and planned research activities. The station's board refused to meet these conditions and managed to collect enough money from the planters to maintain the Sugar Experiment Station without government support

The establishment of sugar experiment stations implied the start of a new connection between the Botanic Garden and colonial agriculture. Treub, director of the garden since 1880, was a botanist with a major interest in experimental botany rather than taxonomy. Treub was from the first generation of biology students to embrace the evolutionary principles of Charles Darwin. The new perspective on species formation implied an entire new perception of organisms, unleashing all sorts of new experimental research.[30] Darwin's theory also implied a new perception of the relation between biology and agriculture. Agriculture was viewed as an area

[28] Snelders, "Landbouw en scheikunde", 84-85. Sirks, *Indisch natuuronderzoek*, 227-228.

[29] Leidelmeijer, *Van suikermolen tot grootbedrijf*, 231-248. Sirks, *Indisch Natuuronderzoek*, 265-271.

[30] See chapter 5. Cittadino, *Nature as the laboratory*, 65-81.

where natural processes developed in artificial conditions. Where in the classical perception the study of nature might lead to benefits for agriculture, in the Darwinian perception the study of agriculture might lead to important insights in the functioning of nature. Besides a modern biologist Treub was also a capable research manager and towards the end of the century he convinced private planter organisations to invest in research at the Botanic Garden in return for solutions to their problems. Although the sugar planters resisted direct interference from Treub, most researchers of the sugar experiment stations were assigned on advice of Treub and the scientists shared experiences and results. Besides his Dutch connections Treub was also well familiar with German botanists who often were appointed at the experiment stations, like, for example, F. Soltwedel, first director of the sugar experiment station of Middle Java.[31] One of the Dutch biologists who later became an ardent critic of the organisation of agricultural science in the Netherlands and the colonies was F.A.F.C. Went (1863-1935), student of Hugo de Vries and director of the sugar experiment station of West Java between 1891 and 1896.

Finally, the role of agricultural education in the organisation of agricultural research was different in the Dutch East Indies. In the nineteenth century there were only some secondary schools for the Europeans who generally sent their children back to Europe for vocational or university education. Towards the end of the century the European planters requested the colonial government to arrange agricultural training facilities for their sons and their Javanese foremen. In 1903 an agricultural school was opened in *Buitenzorg*. Staff members of the Botanic Garden did the teaching and guidance of the students next to their research tasks, a reason why only a limited number of students was admitted each year. Besides, the education was in Dutch, so apart from European youngsters only children from the Javanese elite speaking Dutch entered the school.[32] In the first decade of the twentieth century the agricultural education provided by the research staff of the Botanic Garden became a source of conflict between Treub and the colonial government.

## Research for Javanese agriculture

The improvement of indigenous food crop production, primarily rice cultivation, was since the 1860s, a concern of the colonial government. This concern had roughly two objectives - poverty alleviation and higher returns from taxation. Taxation of the Javanese rural population was arranged in the so-called land-rent system consisting of a levy over the harvest based on acreage and productivity. The improvement of indigenous agriculture, as well as the collection of the land-rent, was done by the internal administration, *Binnenlands Bestuur*. The main mechanism the colonial

[31] Leidelmeijer, *Van suikermolen tot grootbedrijf*, 239. Cittadino, *Nature as the laboratory*, 135.

[32] Perk, *Historische ontwikkeling I*, 40-41.

government used to improve cultivation of food crops was a number of demonstration fields, located near a large village, where improved farming methods were shown to local farmers. The Dutch and Javanese local administrators now and then received circulars where new methods were described, to be implemented on the demonstration fields.[33] In 1899 the responsibility over the demonstration fields was handed over to Treub. For the supervision of the fields Treub appointed local executives, *mantri.* The *mantri* were admitted to the Agricultural School in Buitenzorg that opened in 1903 and in 1907 there were about 10 demonstration fields scattered over the islands Java and Madura. Meanwhile, the colonial government developed bigger plans for indigenous agriculture.

In 1902 Governor General W. Rooseboom wrote the Minister of Colonies that the growth of the indigenous population was resulting in a shortage of land causing a deficit in food production. According to Rooseboom "an indispensable requirement to inform agriculture about its interest for nation and people is a powerful and systematic leadership and continuous supervision of competent experts."[34] In the eyes of the governor the internal administration, *Binnenlandsch Bestuur,* lacked such leadership and he, therefore, proposed to create a separate department for agricultural affairs. The moment he wrote this to the minister Treub had already finished a plan for such a department. According to Treub the Department of Agriculture could be set up around the existing research facilities of the Botanic Garden. "As far as I can see now, the Department of Agriculture requires an increase of staff of the *Buitenzorg* institution only in one direction, that is in the interest of rice cultivation."[35] Furthermore some units of the internal administration were moved to the new department such as cinchona cultivation and veterinary inspection. Initial costs were estimated at 60,000 guilders and annual costs around 106,800 guilders, a bargain compared to the millions that were spent on famine relief in previous years.[36] On the political level food supply and the threat of population growth were appealing arguments. In his explanation in parliament the minister of colonies stressed that "prevention of crop failure and similar disasters is not enough, but first of all serious effort must be put in augmentation of cultivation and bigger production, in order to supply the ever increasing population with sufficient food."[37] Despite the political concern Treub wrote only a few pages about this element but the parliament accepted the plan and the Department of Agriculture became active from 1905.

The new Department of Agriculture incorporated the Botanic Garden and the attached laboratories for botanical, zoological and chemical research. Services

[33] Van den Doel, *De stille macht*, 222-223. See chapter 6.

[34] Creutzberg, *Economisch beleid, eerste stuk*, 278.

[35] Treub, *Schematische nota*, 27.

[36] Creutzberg, *Economisch beleid, eerste stuk*, 282. Hugenholtz, "Famine and food supply", 178.

[37] Idenburg, "Memorie van toelichting", 395.

previously arranged by the colonial administration, like control over plant diseases, fisheries, coffee, cinchona, forestry and veterinary were taken over. Other existing government activities included in the new department were agricultural education, government rubber plantations and the chamber of natural sciences. Regarding indigenous agriculture three new divisions for "observations and investigations" were created, one for indigenous agriculture, one for soils and one for meteorology.[38] The division for indigenous agriculture contained an experiment station, an inspection for indigenous agriculture and the demonstration fields. Main researcher of the experiment station, J.P. Moquette, who left in July 1906 because of illness and was replaced by J.E. van der Stok.[39] Both researchers previously worked at a Sugar Experiment Station on Java. Besides, several other researchers of the laboratories continued in their own fields, like chemistry or phytopathology, but now included the study of annual (food) crops in addition to their regular work on (perennial) plantation crops, wild plants and trees. In short, the major investment for the improvement of indigenous agriculture was an expansion of research activities, performed at the laboratories and experimental fields of the Botanic Garden. For Treub, research was the key to progress, including progress in food production. "The peculiar characteristic, or even better the "essence" of natural science - meaning that progress does not derive from contemplation and logical processing of the already known, but from *new* data by experimenting, observation and its appropriate interpretation - is displayed unabatedly in application to agriculture."[40] Not everyone in the colonial government was convinced about this strong emphasis on research and, for example, the Director of the colonial administration advised the Governor General to pay more attention to practical improvements. Treub replied by explaining that a distinction between scientific and practical results is a "logical error. Such a distinction *does not exist*. Reliable practical results *can only be obtained* by application of scientific results (emphasis taken over from the Dutch text – HM)."[41] Although Treub managed to push his plan through, the criticism of the chosen format was not silenced after the Department of Agriculture was established.

### A scientific view on improvement

The design of the Department of Agriculture, written by Treub in 1902, contained a long explanation of the nature of the new department. Treub distinguished two major types, research departments and administrative departments. According to Treub the latter category of department exercises "a more or less far-reaching

[38] Ibid., 401-411.

[39] *Jaarboek van het Department van Landbouw* (1906), 134.

[40] Treub, *Schematische nota*, 4.

[41] Creutzberg, *Het economisch beleid, eerste stuk*, 290.

technical control and at the most a general guidance."[42] The main task of a research department is "observation, experimentation, collection of data and technical guidance of several installations, organisations and service branches regarding agriculture in the widest sense."[43] Before he distinguished these categories Treub listed the existing agricultural services of various other countries and their colonies. Two striking features of this enumeration are that he did not mention the Netherlands and that he did not group these countries in his categories, with one exception, the United States . "This brochure will have missed its goal entirely when it is does not leave the impression that: first, in the Dutch East Indies the creation of an Agriculture Department is very urgent and, second, that this must be based on the American model."[44] When and how exactly Treub gained acquaintance with the American situation is not entirely clear, but an important source must have been the information brought to him by visiting researchers. In the late 1880s Treub raised funds to cover expenses of foreign researchers coming to Buitenzorg for research work. In 1885 Treub had opened a special Strangers-laboratory (Vreemdelingenlaboratorium), after his death renamed the Treub laboratory, where foreign researchers had their own work space. Many researchers used this opportunity, among others D.G Fairchild of the US Department of Agriculture in 1896. In 1903 Treub visited the United States himself.[45] Treub's fascination for the US Department of Agriculture stands in sharp contrast with his silence about the situation in the mother country. Most likely he did not want to offend the Dutch authorities in the way they arranged agricultural research and extension in the Netherlands. That Treub had a different view on how to set this up becomes clear in 1907.

In his plan of 1902 Treub damped high expectations of the department, because "the power of tradition, established customs (...) as well as specific economical conditions of the many regions imply that improvements will come very slowly and care should be taken to avoid dangerous generalisations."[46] Nevertheless, in 1907, two years after the department's initiation, the colonial government demanded more results and asked the chief inspector of indigenous agriculture, Jacob van Breda de Haan (1865-1918) to come up with additional measures. Van Breda de Haan proposed to increase the extension division (meaning more demonstration fields and thus more personnel to manage these fields). Therefore, Van Breda de Haan argued, not only members of the local elite should be leading the demonstration fields but any Javanese willing and able should enter the Agricultural School in Buitenzorg. After completion the Javanese should be appointed as indigenous

[42] Treub, *Schematisch nota*, 3.

[43] Ibid., 4.

[44] Ibid.

[45] Dammerman, "History of the visitors' Laboratory", 66. Went, "Melchior Treub", 18-19; 30-31.

[46] Treub, *Scematisch nota*, 13-14.

agricultural teachers (*inlandse landbouwleraren*). "These teachers are the agency to disperse better understanding of agriculture among the interested population. In their turn however these teachers should have guidance and instruction."[47] For this supervision Van Breda de Haan proposed to appoint European experts with no specific scientific training. An attentive attitude, general agricultural knowledge and familiarity with the different languages should suffice. Graduates of agricultural schools with some experience in Indonesian agriculture were supposedly suited to the job. Such graduates were amply available as many Wageningen graduates went to the Dutch East Indies to find employment in plantation agriculture.

Treub agreed that the amount of demonstration fields should increase but because only a few *mantri* were trained each year, he considered that a long-term objective. Treub had serious objections against the idea that agricultural advice was given by Javanese not belonging to the local elite.[48] He accepted the supervision of the *mantri* by European experts and in January 1908 four of these agronomists were appointed, followed by a fifth a year later. Treub first agreed that supervision was to be done by agronomists but later he changed his mind. In December 1908 he advised the Governor-General to put pressure on the Dutch government to open a chair in agronomy at one of the universities in the Netherlands. For the time being he considered only candidates with a doctorate in botany or zoology from one of the Dutch universities or a similar degree from a foreign university suitable for the position of agricultural advisor.[49]

It is not exactly clear why Treub changed his mind but considering the timing it is very likely that he was informed about the discussion in the Netherlands regarding the status and organisation of scientific agricultural education. One of the initiators in the discussion was F.A.F.C. Went, since 1896 professor of biology at the University of Utrecht. Went considered the arrival of a growing number of Wageningen graduates in the colonies in combination with the ambition of the Wageningen school to enter the system of higher education as a threat to the position of university graduates in the colonial research institutes. Treub supported Went's criticism and must have realised that his own employment policy was not strict enough on that matter. Besides appointing agronomists as supervisors over the demonstration fields he was very positive over the qualities of his new rice researcher, Van der Stok, a Wageningen graduate. In the same letter to the Governor General where he expressed his preference for university doctors as supervisors over the demonstration fields Treub explained that he changed the temporary job he had offered Van der Stok in a permanent appointment because he

[47] Creutzberg, *Economisch beleid, eerste stuk*, 317.

[48] Ibid., 324, 346.

[49] Ibid., 384.

was impressed by his competence and energy.[50] Shortly afterwards Treub was to experience what his colleague Went worried about.

### An educational view on improvement

In 1908 Treub tried to silence his critics with new activities for rice production. He proposed to intensify the selection work performed by Van der Stok, and launched the idea of a government rice farm (*overheidssawah)* in order to discover "the factors whose interaction will guarantee a maximum yield of the paddy fields on Java". The colonial government asked the head of the Directorate of Agriculture in the Netherlands, H.J. Lovink (1866-1938), for advice on the proposal. Lovink was not convinced by the plan. In his response he first presented some of the experiences with agricultural extension in the Netherlands and then drew the conclusion that barriers for progress and deficiencies in knowledge must be sought on the individual farms and from farmers. According to Lovink an experimental rice farm will not reveal real shortcomings, and will only have scientific value and hardly any practical use. "It therefore seems that Professor Treub is not taking the right position. The question is not what maximum possible amount of rice can grow on a certain area, but how it will be possible, once acquainted with rice cultivation as conducted by the Javanese, to increase together with the Javanese farmer his rice yields economically, taken into account his development, workforce and his capital."[51] Lovink wrote this in July 1909 and in December of the same year he was appointed to the position of Treub, who was repatriated because of illness. The model farm was never accomplished and Lovink largely implemented the ideas of Van Breda de Haan. In 1913 the agricultural school in Buitenzorg was upgraded and provided education for "youngsters of any nationality in agriculture and forestry, and education of indigenous young men for the office of Aspirant Agricultural Teacher, trainee for the indigenous Folk Credit Service and Indigenous Adjunct Forester."[52] Moreover, Lovink appointed several European agricultural advisors for which the requirements were not a doctorate in botany or zoology but a certificate of the State Agricultural School in Wageningen.[53] The Dutch and Javanese functionaries together formed the colonial Extension Service, established in 1911. The extension work also comprised supervision over new agricultural schools in different parts of Java and an increasing number of demonstration fields, moved

[50] Ibid., 343.

[51] Ibid., 387.

[52] *Jaarboek van het Department van Landbouw* (1913), xii.

[53] Van den Doel, *De stille macht*, 232-234.

from a central location near larger villages to the rural areas.[54] In short, Lovink more or less copied the model of extension as set up in the Netherlands.

Much of the difference between Treub's and Lovink's models can be related back to their backgrounds. Treub was an academic botanist with high expectations about experimental research in biology and related disciplines. Progress in agriculture could only emerge out of scientific research protected from too much outside interference. Useful innovations coming out such research will find its way to practice by itself. Lovink was a self-educated agronomist convinced that commitment to agriculture is as important as scientific training. When inquiring about candidates for vacant positions his standard question was "does he think agriculture?"[55] Another difference between Lovink and Treub was their perception of the indigenous population. Treub was rather condescending about Javanese farmers and the future prospects of indigenous agriculture. In 1910, looking back on his work as director of the Department of Agriculture, he sketched a pessimistic future for indigenous agriculture, because "the native is entirely lacking any economic insight."[56] Lovink on the other hand sees no big difference between Dutch and Javanese farmers. He considered both as suspicious towards innovations mainly caused by a lack of knowledge.[57] Although much of the differences in approach between Treub and Lovink can be related to their personal backgrounds, these backgrounds were not only personal but also institutional.

### Research and application as distinct categories

Between 1901 and 1909 Lovink headed the Directorate of Agriculture in the Netherlands and guided in those years a series of reorganisations of the State Agricultural School in Wageningen. This process was set in motion after the government proposed to change the Higher Education Act and include technical, economic, veterinary and agricultural education. The amendment passed in 1905.[58] These changes provoked a discussion about the status and location of agricultural research and higher agricultural education. There were two positions in the debate, one advocating academic status for a reorganised Wageningen school, the other favouring the creation of a faculty of agriculture at one of the universities. Most of the arguments were put around principles of science and its application in practice, but there were also some more mundane issues at stake. There was, for example, some competition between the universities of Groningen and Utrecht. In 1905 members of the University of Groningen together with representatives of agricultural societies in the northern Netherlands created a Society of Higher Agricultural

[54] *Jaarboek van het Department van Landbouw* (1911), ix-xii. Ibid. (1912), viii-x.

[55] Van der Poel, "Lovink, Hermanus Johannes", 363.

[56] Treub, *Landbouw*, 29.

[57] Creutzberg, *Economisch beleid, eerste stuk*, 386.

Education *(Vereeniging voor Hooger Landbouwonderwijs)* pleading for Groningen as the centre of agricultural science.[59] Representatives of the University of Utrecht tried to incorporate agricultural research and education on the grounds that this should be combined with veterinary education. The veterinary school in Utrecht, created in 1821, aspired like Wageningen to academic status and the university was willing to incorporate both.[60] In the Dutch East Indies the universities defended another interest.

Wageningen graduates were mainly employed in plantation agriculture and the forestry service. The main activity of the graduates working in plantation agriculture consisted of maintenance of the crops and experimenting with agronomic improvements. The private experiment stations were mainly staffed with university graduates. If the Wageningen institution was granted academic status the graduates of the school formally would have the same education level and therefore could not be refused research positions on that ground. In a similar way the appointment of Lovink and the arrangements he introduced at the Department of Agriculture were considered a danger for university graduates. In 1910 Treub wrote a review of the activities of the Department of Agriculture and one of the issues he discussed was the supervision of demonstration fields. In Treub's view the decision to have him replaced by Lovink implied that the colonial government "receded from the necessity of scientific agronomic extension."[61] In this brochure Treub formulated his bitterness rather mildly compared to a telegram in which he called Lovink's appointment the "grossest denial of significance of natural science for agronomy."[62] The receiver of this message was most likely Frits Went, who must have read it with approval. Went was a prominent fighter against too much Wageningen influence in the colonies.

After he left the sugar experiment station in 1896 Went became professor of biology at the University of Utrecht. Here he promoted the interest of colonial agriculture, made several journeys to the West Indies to advise about setting up research institutes, and frequently discussed colonial affairs in newspapers and magazines. Furthermore, he put much effort into posting his students to the colonial research institutes.[63] For Went it was clear that only university-trained researchers were able to obtain innovative and solid research results. Agronomists from Wageningen were not more and not less than competent and useful practitioners. This is not just a matter of education but also a difference in mentality. "The former asks why, and tries to perceive the causal relations, the latter's whose whole life is

[58] See chapter 4.

[59] Addens, *Vereeniging voor hooger landbouwonderwijs*, 95-105.

[60] Goudswaard, *Agrarisch onderwijs*, 124-135. Van der Haar, *Geschiedenis I*, 114-119.

[61] Treub, *Landbouw*, 70.

[62] Cited in: Van der Schoor, "Biologie en landbouw", 157.

[63] Van der Schoor, "Biologie en landbouw", 145-161.

aimed at deeds, on results for the interest of practical life."[64] According to Went the different mentality of students will result in a sort of natural selection: "the one who feels scientific preferably goes to a university, the practical man chooses the Technical College, the Agricultural College, and so on."[65] Went wrote this in 1914, and at that moment the move of the school in Wageningen from the system of Middle Education to Higher Education was almost certain. For Went, however, the status of the education did not influence the difference between a scientific or practical attitude. Moreover, he always stressed that both types were indispensable. "Without the man of deeds the world would be ruined immediately, without the scientific researcher there would be no progress and the world would remain in the same position."[66] Because of this mutual dependence Went considered the integration of both types of education in a university as the ideal situation.[67] Most lecturers of the school in Wageningen, however, considered the distinction a denial of the capacities of Wageningen graduates.

**Research and application as fluid categories**

Graduates from the Wageningen school reacted in several journals on the writings of Went, criticising his sharp distinction between men of deeds and men of science. One of the lecturers of the State Higher School for Agriculture, Horticulture and Forestry (*Rijks Hoogere Land-, Tuin-, en Bosbouwschool)* and university graduate J. Ritzema Bos (1850-1928) wrote a complete article on the issue. Ritzema Bos considered Went's position as questionable and "specifically raises an objection to the contempt he expresses for all that is applied science."[68] Went's research of the early 1890s on cane disease was familiar terrain for Ritzema Bos. According to Went that research made clear how important scientific research was for practice. Went argued that he and other botanists discovered various parasitic fungi and therewith opened the way for effective pest control. Ritzema Bos opposed by showing how planters on Java as well as farmers in the Netherlands had already found cures for several diseases before causes of pests and diseases were known and he questioned the necessity of scientific research for that. "Without taking away the merits of the research of Went concerning the causes of the disease in sugar cane, I believe that practice would have found a proper remedy even without his research."[69] Ritzema Bos argued that a phytopathologist should be informed about the activities of farmers in order to solve problems in collaboration with practice.

[64] Went, *Wetenschap en tropische landbouw*, 3.

[65] Ibid., 4.

[66] Went, "Reisbrieven", 1134.

[67] Ibid., 1530.

[68] Ritzema Bos, "Plantkunde en landbouw", 2.

[69] Ibid., 7

Contary to Went he did not consider this as a matter of mental attitude but a matter of education and he considered university education as too narrow. "He who wants to perform as phytopathologist does not only need proper education in botany, but has to study other natural sciences too, and this in a direction that is often neglected at the universities."[70] Therefore the best phytopathologists were not university trained botanists, because "they often know nothing about the cultivation method of plants, know too little of zoology, chemistry and physics, often know very few plants, and foremost lack any *feeling* for agricultural practice."[71] Ritzema Bos further argued that Went's position is driving science and practice apart, overestimating the potential of science, and would in the end be counter-effective. "[T]herefore a modest performance is necessary because expressing ungrounded opinions from a superior position, opinions that later have to be taken back, often prompted the farmer to take a sceptical attitude towards natural science."[72]

The two different views on a fruitful connection between science and practice had direct consequences for the organisation of agricultural research. Went not only expressed his view in relation to the Dutch East Indies, but also commented on the reorganisation of the experiment stations in the Netherlands going on in the same period. In Went's view the split between control analyses and experimentation was a proper distinction between practical activities and research. "For the first mainly subordinate staff will be employed that have no scientific aspirations, whereas for the other the requirement will be that persons employed there must be able to perform autonomous scientific labour."[73] This interpretation is probably the 'misconception' Hissink had in mind in 1915 when clarifying the reorganisations discussed in the previous part of this chapter. Regarding the private experiment stations in the Dutch East Indies a distinction between control analyses and research work was not an issue and Went drew the line here between research and extension. "Daily advice will be provided by men of deeds, who are scientifically trained, in such way that they have all data that science can provide at their disposal. They are not necessarily employed by an experiment station; I would even say that it is better when such advisors are employed by large planter enterprises or trade corporations, like now is often the case."[74] The managing boards of the private experiment stations, however, never followed Went's advice and employed researchers and extension workers with certificates from a university or from the Agricultural College. In short, the attempts of Went to reserve the research activities at the agricultural experiment stations for university graduates did not succeed. The authorities of the government institutes and

[70] Ibid., 16.

[71] Ibid., 12.

[72] Ibid., 30.

[73] Went, *Plantkunde en landbouw*, 28.

[74] Went, "Reisbrieven", 1135.

services, as well as the managing boards of the private experiment stations, considered a fluid distinction between research and application to practice as a better base for the organisation of the institutes.

### The General Experiment Station for Agriculture

Ironically, the institute that came closest to an ideal organisation as perceived by Went was the colonial Department of Agriculture. The main reason why Lovink came to Buitenzorg was to improve the food supply of the indigenous population. As he was not personally interested in botanical research, he split up the functions of Head of the Department and Head of the Botanic Garden that Treub had combined during his directorship. For the latter position Lovink appointed in 1911 J.C. Koningsberger, a biology graduate from the University of Utrecht. Koningsberger headed the garden, the herbarium, a mountain garden outside Buitenzorg, a station for marine biology in Batavia and laboratories for botany, zoology and pharmaceutics. Other major research divisions, headed by other officials, were a phytopathology service for plantation crops, a soil chemistry lab, a geology lab and a bacteriology laboratory. The Extension Service, containing Dutch and Javanese agricultural advisors, became a separate division, including the seed gardens that used to be part of the Experiment Station for rice and other annual crops (*Proefstation voor rijst en tweede gewassen*).[75] In other words, Lovink separated extension and improvement of food crops from the various research activities. Whether Lovink set up the Department in this way to avoid possible conflicts with the botanists is not clear. In any case, the split was not the only change in the department. Since 1911 the mandate of the Department of Agriculture included state activities for industries and trade and was called *Departement van Landbouw, Nijverheid en Handel*. Most of the industries and trade activities were directly related to agriculture and the affix 'industries and trade' primarily signified the attempt of the colonial government to steer the agricultural economy, especially the indigenous agricultural economy, resulting in the creation of a special economy division in 1918. In 1918 Lovink repatriated and was replaced by J. Sibinga Mulder (1866-1944). The new Director-general initiated a new series of reorganisations.

[75] *Jaarverslag van de Landbouwvoorlichtingsdienst* (1912-1929).

**Table 3: Agricultural research institutes in the Dutch East Indies. Location and number of senior staff in brackets. (Source: *Vergadering van de vereniging van Proefstation-Personeel, 1935.*)**

| Public research institutes and services | Private research institutes and servicies |
|---|---|
| 1. General Experiment Station for Agriculture (Buitenzorg, Java; 40) | 1. General Experiment Station of the Rubber association AVROS (Medan, Sumatra; 9) |
| 2. Forestry experiment station (Buitenzorg, Java; 13) | 2. Deli-Experiment Station (Medan, Sumatra; 6) |
| 3. Laboratories for caoutchouc, hevea, coffee and kapok (Buitenzorg, Java; 5) | 3. Plantation Research Department, US Rubber Plantations (Boenoet, Sumatra, 11) |
| 4. Magnetic and meteorological observatory (Batavia, Java; 3) | 4. Scientific Service of the Rubber Culture Company 'Amsterdam' (Galang, Sumatra; 5) |
| 5. Botanic Garden (Buitenzorg, Java; 3) | 5. Exp. Station for Rubber (Buitenzorg, Java; 9) |
| 6. Treub-laboratory (Buitenzorg, Java; 1) | 6. Exp. station for tea (Buitenzorg, Java; 8) |
| 7. Herbarium and Museum for systematic botany (Buitenzorg, Java; 5) | 7. Exp. Station Middle-Java (Salatiga, Java; 2) |
| 8. Phytochemical lab (Buitenzorg, Java; 2) | 8. Exp. Station Malang (Malang, Java; 6) |
| 9. Zoology museum and laboratory (Buitenzorg, Java; 5) | 9. Besoeki Exp. Station (Djember, Java; 5) |
| 10. Laboratory for marine biology (Batavia, Java; 2) | 10. Experiment Station for Cinchona (Pengalengan, Java; 5) |
| 11. Division for Industries (Buitenzorg, Java; 7) | 11. Exp. Station for Tobacco (Klaten, Java; 6) |
| | 12. Exp. Station for the Java sugar industry (Pasoeroean, Java; 42) |

In August 1918 the department created a new division, the General Experiment Station for Agriculture (*Algemeen Proefstation voor de Landbouw,* APL). The first director of the APL, chemist and soil scientist E.C.J. Mohr (1873-1970), explained the purpose of this station. "The large, well established European cultures that can afford it, like sugar, tobacco, tea, rubber etc. have their own 'specific' experiment stations; but the indigenous cultures, as well as new starting or small European cultures, come for advice to the General Experiment Station."[76] In the first year the station contained laboratories for soil-biology, agro-geology and soil research, botany and chemistry. In 1922 the 'Selection and seed garden' of annual crops in Buitenzorg was taken out of the Extension Service and included in the APL. A year earlier the division for selection of perennial crops was already included and in 1926 the Phytopathology Service was added to the station. Over the years several laboratories and divisions were grouped together under the name institute. In 1935 the APL employed 40 senior (Dutch) staff members divided over a Botanical Laboratory (3), a Chemical Lab (1), a Soil Institute (8), an Institute for

[76] *Jaarboek van het Department van Landbouw* (1918), 197.

Phytopathology (12), an Agricultural Institute (11) and a Coconut Experiment Station located at Menado on Celebes. (3). The remaining two senior employees were commissioned with a soil survey of Sumatra.[77] The botanical laboratory became an institute for plant sciences in 1941 and in the same year the Agricultural Institute was renamed as Culture-technical Institute, (*Cultuurtechnisch Instituut)*.[78]

The grouping of the different research divisions of the Department of Agriculture under the General Experiment Station for Agriculture implied an organisational integration and co-ordination of the various sorts of research for indigenous agriculture. Besides this horizontal integration the vertical linkages were improved as well. The main mechanism for the connection between research divisions and the Extension Service was the organisation of field experiments. The changes in the organisation of the demonstration fields, as described above, was more than a mere quantitative growth. As the name already suggests, the function of the fields was to demonstrate farming methods, new crop varieties, new fertilisers etc. The changes put through by Lovink also implied that besides showing innovations, the fields were also a mechanism to acquire information about the local conditions for farming. In other words, the fields became a kind of scale models for the entire region, making a two-way intermediary between the researchers and the Javanese farmers. Crucial for the functioning of this exchange was the question how representative the fields were for the region. This problem was primarily solved with mathematical statistics, providing methods for inference, as well as for the lay out of experimental plots. The development and implementation of these methods gradually improved in the 1920s, resulting in a standardisation of field experiments and centralised processing of data.[79] The centralised coordination of experimentation and data processing was performed by the Agricultural Institute of the APL.

## Centralised agricultural research

Looking at the organisation of the Department of Agriculture over the first half of the twentieth century gives the impression that the department was almost continuously changed and reorganised. Until now the changes described were mainly induced by crucial decisions in the direction and objectives of the department of agriculture. However, the economic depression of the early 1920s and the more severe crisis of the 1930s impelled the Department of Agriculture to shrink. Especially in the 1930s this induced a revival of the debate over the distinction between pure research activities and research work more related to

[77] *Verslag van de vergadering van het technisch personeel* (1935), 196-197.

[78] Toxopeus, "Landbouwkudnig onderzoek."

[79] Ossewaarde, *Proefveldonderzoek*, 33-37. See chapter 7.

practice. Similar to the late 1900s and 1910s, the debate covered both public and private research institutes.

The reduced returns of plantation agriculture in the 1930s made many plantation owners stop their contribution to the experiment stations. Consequently, the experiment stations had difficulties bearing the costs of the research work and therefore the syndicate of private experiment stations called for government support. In 1933 a special law arranged the creation of a Central Association of Experiment Stations. The association co-ordinated and supervised agricultural research. "The programmes of all experiment stations will be determined every year by mutual agreement between directors of the station and representatives of government and entrepreneurs. The aim is a rational division of tasks, to avoid double work. (...) For appointment of new staff a commission will be consulted, in which a representative from the Agricultural College, from the Technical College and from one of the universities is seated."[80] The author of the piece, Wageningen graduate D. Tollenaar, expressed the hope that when the crisis was over the association would be continued in a similar organisation. "This organ of applied scientific research of the experiment stations must be centrally lead, in which the general economic interest of the State and the private companies set the course of the research and not, like in the old days, the ideas of individual researchers (although they must have great freedom in performance of the research)."[81] Not every researcher was equally happy with the situation, and in fact Tollenaar's article was partly a response to a discussion initiated by the successor of F.A.F.C. Went.

The article that made Tollenaar and others reach for their pens was written by V.J. Koningsberger (1895-1966), son of the former director of the Botanic Garden, J.C. Koningsberger and biology professor in Utrecht from 1934. V.J Koningsberger argued that since Treub had left the Dutch East Indies, fundamental research at the Botanic Garden was split off from applied research and systematically oppressed. Koningsberger warned that if this development persisted all fundamental research and progress would come to a halt.[82] The different respondents accused Koningsberger of nostalgia and a wrong interpretation of the connection between fundamental and applied research. In the situation of the 1930s the Botanic Garden "cannot possibly provide the basis for all the applied natural-scientific work (...)."[83] Similarly, the idea that fundamental science is the basis for progress is questioned. "With all respect for Treub, it seems to me that he has gone too far in the position he wanted to assign to science as an organ of

[80] Tollenaar, "Ontwikkeling en toekomst", 246.

[81] Ibid., 253.

[82] Koningsberger, "Het werk van Melchior Treub", 249-258.

[83] Dammerman, "Een antwoord", 409.

general administration."[84] Where the two cited authors rejected the ideas of Koningsberger, Tollenaar tried to reconcile the opponents, arguing that the current centralisation of research activities should watch over fundamental research. "It appears to me that a far better structure would be that a central organisation considers what fundamental research is of special use and urgency, from which a limited number of issues will be selected."[85]

The organisation of agricultural research in the Dutch East Indies was divided over a number of institutes and services that during the 1920s and 1930s moved in a direction of centrally guided coordination and interaction. A strong separation of fundamental and applied research, as advocated in the first two decades of the twentieth century, was not considered as very fruitful. Even the son of F.A.F.C. Went, F.W. Went, rewriting a short history of botanical research in the colonies of his late father, admitted that such a separation was not desirable. "It tended to draw lines where no real barriers existed, and it dissociated the Botanic Gardens from those ventures which had given them their main impetus of development (...). During the last years this mistake was remedied, and through a complete reorganisation of all research institutions, both pure and applied, under one directorate, the rift between pure and applied research was bridged again, and a period of renewed vigorous botanical activity, cut short by the Japanese invasion, was anticipated."[86] In this harmonic format many Wageningen graduates, like Tollenaar, had become distinguished researchers and although some rivalry with university graduates remained, there were no more official barriers between graduates form universities and colleges. As the quotation makes clear, the second World War implied the end of agricultural research and extension as organised in the Dutch East Indies. After the war the Dutch restarted all the public research institutes and services but in 1949 the independent government of Indonesia took over and all former colonial officials of Dutch descent were expelled. Dutch employees of the private experiment stations were allowed to stay, but gradually left as well.

## Agricultural research in the Netherlands 1930s-1970s

The story of the developments in the Netherlands in the first part of this chapter ended with the criticism of Blaauw on the tasks of the research institutes attached to the Agricultural College (*Landbouwhogeschool*). Blaauw was a Utrecht trained botanist and member of the Royal Academy of Science (*Koninklijke Akademie van*

[84] Mansvelt, "De omzetting", 131.

[85] Tollenaar, "Ontwikkeling en toekomst", 251.

[86] Went and Went, "A short history of general botany", 392.

*Wetenschappen).* It was the Royal Academy that launched the idea to stimulate applied research by organising it. The initiative dates from 1917 and a year later the government installed a "scientific commission of advice and research in the interest of public welfare and defence."[87] The commission was rather large and never formulated concrete proposals but one of its members, I.P. de Vooys, professor at the Technical College (*Technische Hogeschool*), in Delft advised the government to install a smaller commission to formulate ideas on how existing research activities (public and private) could be structured. The government followed the advice; F.A.F.C. Went was appointed as chairman and the objective was "to investigate by which measures and in what form applied natural-scientific research in this country can serve the public interest more substantially."[88] The commission published its report in 1925; the parliament accepted the law based on the proposal in 1930, and the law was implemented from May 1932.

Most of the ideas written down in the report were included in the law of 1932 except for one. The commission had proposed to concentrate all existing laboratories, experiment stations, institutes and services related to various economic activities under one umbrella organisation for Applied Natural-scientific Research (*Toegepast Natuurwetenschappelijk Onderzoek,* TNO). The crux of the plans as laid out by the commission chaired by Went was the private status of TNO, implying that employees of the services and institutes transferred to the new organisation would lose their legal rights as civil servants. With better salaries the TNO organisation should prevent private corporations buying out talented researchers. Flexibility in appointment terms would allow dismissal of researchers who lost their productivity. The law of 1932, however, did not follow the report on that element. Employees of government research institutes kept their civil servant rights when transferred to the TNO organisation.[89] This adjustment, together with the fact that a transfer of existing institutes and researchers to the TNO, was not enforced meant that the sting was taken out of the original proposal. For the agricultural research institutes the TNO became a competitive organisational format to the ministerial Directorate of Agriculture.

The main economic fields that the TNO had to cover were industry, agriculture, trade and fisheries. The general organisation contained some research institutes, but its main task was supervision of special organisations. The first special organisation was created in 1934, focusing on industry, trade and traffic. The second, created in 1940, included food. In 1943 two special organisations were created, both related to agriculture. One was the organisation for agro-industries, looking at processing of agricultural products, and the other was the organisation for agriculture. The first never set out concrete research activities, and was

[87] Al, *Research als overheidstaak*, 24-25.

[88] Ibid., 31.

[89] Ibid., 66. Baggen, Vorming door wetenschap, 125-126.

included in the industrial organisation in 1951 and abolished in 1959.[90] President of the second, the Agricultural Organisation TNO (*Landbouworganisatie TNO)* was O. de Vries. In the 1920s De Vries headed the Rubber Experiment Station in the Dutch East Indies and in 1930 he repatriated, receiving the directorship of the Agricultural Experiment Station in Groningen and the related Institute for Soil Research (*Bodemkundig Instituut)*. These were the only agricultural research institutes ever transferred from the Directorate of Agriculture to the TNO organisation.[91] The Agricultural Organisation TNO did create two institutes itself, one for forestry research and the other for cattle rearing. When O. de Vries died in 1948 the directorship of the Agricultural Organisation TNO was handed over to the Director-General of Agriculture, C. Staf.[92] In the period that Staf and his successor (A.W. van de Plassche) headed the Directorate of Agriculture, no other research institute or services were brought under the TNO umbrella. In 1957 is was decided to change the Agricultural Organisation TNO into a National Council for Agricultural Research (*Nationale Raad voor Landbouwkundig Onderzoek*, NRLO).[93] The transformation of the Agricultural Organisation into a council implied that the aim to incorporate agricultural research institutes in the TNO was abandoned. Supervision and responsibility over the Groningen institutes and the research stations for forestry and cattle rearing was moved back to the Directorate of Agriculture. The National Council became a sort of science policy instrument for the Ministry of Agriculture, maintaining its contacts with the TNO organisation.

### Centralisation of agricultural research

During the years the organisation for Applied Natural-scientific Research (TNO) was prepared and implemented the discussion among Wageningen professors about the organisation of agricultural research continued, often with a clear eye on the establishment of TNO. A major issue in that respect was the position of the research institutes attached to the Agricultural College in Wageningen. The law that arranged the university status of the Wageningen institution included an article stating that a research institute is meant to conduct research and besides "can be reserved as an institute for advice to practice or the implementation of government measures."[94] Many professors of the Agricultural College shared the criticism of Blaauw on this matter. As a first result of these complaints the Phytopathology Service was taken out of the management structure of the

[90] Van Kasteel, "Ontstaan en groei", 27. Verkaik, *Organisatiestructuur landbouwkundig onderzoek*, 40-41.

[91] Bruin, "Ontwikkeling van het landbouwkundig onderzoek", 146-153.

[92] Van de Plassche, "TNO in dienst van de landbouw", 99-101.

[93] Ibid. Verkaik, *Organisatiestructuur landbouwkundig onderzoek*, 40-43.

[94] Cited in: Van der Haar, *Geschiedenis I*, 165.

Agricultural College, but the Phytopathology Institute remained part of the college organisation.

Reactions on the planning and implementation of the TNO invoked several responses in Wageningen. The most negative reaction came from the board of trustees of the Agricultural College. When Went presented the report in 1925 the trustees warned the Wageningen senate that the idea to concentrate all agricultural institutes in the TNO organisation "implies a heavy bleeding for Wageningen."[95] Other responses were less conservative, and an interesting account comes from the director of the Institute for Plant Breeding in the 1920s and 1930s, and professor in plant breeding, C. Broekema (1883-1940). Broekema considered the idea behind the TNO as an incentive for better arrangements between the public and private sector. Broekema himself put most of his energy in contacts and arrangements with agencies in the agrarian sector and left research activities to other members of the institute. Based on his experiences in the breeding sector he argued for more participation of private agencies in agricultural research. "There is no sharper control on the effect of research and extension than by the contributing parties. If that is missing, then all that remains in the end is unbridled bureaucracy. (...) In my view the farm sector has to start financing more and more the needed research for itself. And this is possible, because research directly aimed at practice pays."[96] For Broekema the farm sector included farmers and industrial companies. He was involved in several initiatives in creating such linkages as, for example, barley research sponsored by malting plants, breweries and barley growers. According to Broekema this is exactly the sort of arrangement the TNO was created for.[97] The position of Broekema is more or less opposed to the ideas of Blaauw, discussed in the first section of this chapter. Although both professors agreed that the organisation of agricultural research could be improved, Broekema considered linkages with private agencies in agricultural practice a positive development and pleaded for the formalisation of such shared research activities. Blaauw considered close ties with agricultural practice as threatening for the freedom of research and pleaded for a clear difference between experiment stations and the laboratories of the Agricultural College, a construction without the research institutes. But both professors saw developments going in a different direction.

Similar to the developments in the Dutch East Indies, an important mechanism in establishing a connection between science and practice was the development of field experiments and the statistical processing of data generated by these experiments. Besides a centralised planning and standardised methodology the results of the field experiments were centrally processed in (statistically sound) results. The institute that performed the task of processing experiment results was

[95] *Archive Lh*, 1160.

[96] Broekema, "Organisatie van het landbouwkundig onderzoek", 178.

[97] Ibid., 184. Maltha, *Honderd jaar landbouwkundig onderzoek*, 64-69.

the Central Institute for Agricultural Research (*Centraal Instituut voor Landbouwkundig Onderzoek*, CILO) created in 1939 and located in Wageningen. Besides data processing the institute incorporated some of the task of the Groningen experiment station and covered research for arable crops and pastures, covering the entire Netherlands. The developments in field tests and the creation of a Central Institute for Agricultural Research makes clear the TNO objectives (making applied natural-scientific research more effective through a central organisation) was also pursued and implemented by the Directorate of Agriculture. It might even be the case that the name of the CILO was chosen as a signal that agricultural research did not need involvement of the TNO. When coordination of agricultural research institutes was taken out of the mandate of the TNO organisation in 1957 the CILO was given a new name, Institute for Biological and Chemical Research.[98] The centralisation of agricultural research however was primarily an organisational process, implying that the Directorate of Agriculture became more active in initiating new research, resulting in the creation of many new institutes, especially during the 1940s.

In the period 1940-1948 new agricultural research institutes were created - including an institute for agricultural economics, two institutes for horticulture, one for plant varieties, one for flax and an institute for applied biological research. The latter was initiated by the TNO organisation. Moreover, the service that arranged the reclamation of the polders (*Cultuurtechnische Dienst)* set up its own research division, making a total of eight new institutes. The legal format of these institutes was a foundation. This formula implied legal independence from the government, allowing funding of research by private agencies. Nevertheless, management decisions and research activities were dominated by the demands of the Directorate of Agriculture. The institutes that were related to *Landbouwhogeschool* followed this trend. The activities of the Institute for Plant Breeding for example were divided over the Institute for Variety Research of agricultural crops (*Instituut voor Rassenonderzoek voor landbouwgewassen)* created in 1942 and the Foundation for Plant Breeding (*Stichting voor Plantenveredeling)* in 1948. The Institute for Plant Breeding continued with research and education activities within the organisation of the Agricultural College.[99] The Institute for Agricultural Machinery and the Institute for Phytopahtology made a similar move and became foundations too.

### Differentiation and interaction

The transfer of agricultural research institutes into separate foundations not only created legal space to combine public and private interests but also implied independence from the Agricultural College. Professors from the *Landbouwhogeschool* no longer combined their professorship with the function of director of a

[98] Ibid., 102-113.

[99] Ibid. *Archive Lh*, 1575. See chapter 5.

research institute. A clear situation so it seems, but a relation between Wageningen professors and the research institutes was considered desirable by representatives of all parties. But how far such interaction should go and how it should be officially arranged were questions that appeared difficult to answer.

A first commission that expressed its view on the matter was installed by the Wageningen senate in 1950 and chaired by the Wageningen professor in tropical-agrarian economy, E. de Vries (1901-1993). The commission had the assignment to investigate the co-operation between agricultural research, education and extension. The commission repeated the wish of Went that all agricultural research should be brought under one co-ordinating body, preferably a TNO organisation.[100] Concerning the role of the professors the commission expressed the worry that in order to perform its education tasks "the *Landbouwhogeschool* cannot only be a school, an isolated apparatus, without sufficient contact with agricultural practice, kept away from the big current issues, sterile, with modest facilities and professors who, once ended up in this fortress, soon cannot speak from their own experience in lectures."[101] The commission thought this could be avoided by maintaining personal contacts between the college and the research institutes as well as by offering part-time professorships to distinguished researchers of the institutes. Furthermore, the commission considered it possible for laboratories of the *Landbouwhogeschool* to perform some of the research tasks. Therefore representatives of the college should be included in the TNO organisation. "In the distribution of work and the plans made there the *Landbouwhogeschool* can join the conversation and determine how it can contribute."[102] The commission chaired by de Vries expressed mainly its concern that the college will lose contact with the research institutes and therefore should have a vote in the planning of the research activities. But the view of the commission chaired by De Vries was opposed by two other commissions that reported on the organisation of agricultural science.

In 1955 the minister of agriculture assigned a commission chaired by professor in agrarian law, J.M. Polak, to prepare a reorganisation of the Agricultural College. The commission offered its report to the minister in the same year and advised against any format that would bring the research of the institutes and college back together. "The creation of a co-ordinating organisation will harm the intrinsic nature and character of both Agricultural College and institutes; it would not bring a solution for problems that have arisen in practice, and it would extend already lengthy and laborious arrangements and split up responsibilities."[103] The ideas of the commission chaired by Polak were further elaborated by a ministerial commission chaired by V.J. Koningsberger, professor in biology at the University

[100] De Vries, "Het landbouwkundig onderzoek ", 876.

[101] Ibid., 875.

[102] Ibid.

[103] Cited in: Verkaik, *Organisatiestructuur landbouwkundig onderzoek*, 45.

of Utrecht. In 1961 the commission published its report under the title "Fundamental research in agriculture." The commission advised on the creation of new chairs and made several recommendations for the improvement of the education. In fact a closer interaction between research and education was considered very healthy for fundamental research. "At the one hand this is necessary for the professor, who has to live in an environment of scientific practice so that he will be able, with the fast development of science, to teach objectively and critical and to maintain the required level. On the other hand it is necessary that the student, who will later find employment in fundamental research, already during his study is in an environment where science is practised intensely."[104]

Regarding the relation between the Agricultural College and the research institutes the commission worried about the disproportionate growth of research capacity at the institutes in relation to the laboratories of the Agricultural College. It estimated that the material capacity of the institutes was ten times higher than at the laboratories of the college. "Assuming that staff members of the Agricultural College spend on average 50% of their time on education, results also for research staff that institutes have ten times more capacity than the departments of the Agricultural College."[105] According to the commission this unbalanced growth was partly due to the lack of a programme for research of the *Landbouwhoge-school*. The commission recommended to increase the number of chairs, research staff and research facilities. Moreover, research would be stimulated when a research coordinator was appointed. "Of course such coordination may never lead to any compulsion of what research items should be taken up by the departments. It is however reasonable to expect that the wish of certain departments for more investments in research is accompanied by argumentation, that the mentioned official can examine in the light of the general research programme of the Agricultural College."[106] The proposal of the commission chaired by Koningsberger implied two levels of research co-ordination. One on the level of the Agricultural College and one on the level of research institutes. What happened in the late 1960s and 1970s was in fact the establishment of three levels of research co-ordination.

### Agricultural research and the ministry

The Ministry of Agriculture maintained an ambiguous attitude towards the TNO organisation. After the establishment of the National Council for Agricultural Research (NRLO) the Ministry of Agriculture started to organise research coordination as well. In 1963 the ministry created a General Directorate

[104] Koningsberger, *Fundamenteel onderzoek in de landbouw*, 11.

[105] Ibid., 33.

[106] Ibid., 35.

Agricultural Extension and Research with as one of the branches a Directorate of Coordination of Research. The General Directorate was split in 1968 into a Directorate Agricultural Production, Processing and Marketing and a Directorate Agricultural Research (*Directie Landbouwkundig Onderzoek*, DLO).[107] In 1970 the NRLO broadened its objectives and became an organ in which "all agricultural research and its connection with other scientific research can be subject of study, consultation and cooperation."[108] In the same year the Directorate of Agricultural Research of the ministry changed its sphere of activity to "affairs regarding the coordination of applied-agricultural research."[109] Meanwhile, the coordination of research at the Agricultural College as proposed by the commission chaired by Koningsberger was implemented and had grown to a senate commission of 9 persons. Early 1970s the management structure of all universities was drastically changed, implying more influence of non-academic staff and students over the management decisions. The commission for research coordination now had a permanent membership of thirteen persons, including non-academic staff members and students.

[107] Verkaik, *Organisatiestructuur landbouwkundig onderzoek*, 48-49.

[108] Ibid., 81.

[109] Ibid.

**Table 4: Division of agricultural research institutes in the Netherlands, 1970. (Source: Verkaik, *Organisatiestructuur landbouwkundig onderzoek*.)**

| Directorate Agricultural Production | Directorate Agricultural Research | Special Government Services | National Council Agricultural Research - TNO | Agricultural College |
|---|---|---|---|---|
| Experiment stations for:<br>1.Arable crops<br>2.Cattle rearing<br>3.Flower culture<br>4.Tree culture<br>5.Mushroom culture<br>6.Fruit culture<br>7.Greenhouse culture<br>8.Vegetables<br>9.Bulb culture<br><br>Extension Service | Research Institutes and centres for:<br>1. Farm households<br>2. Plant physiology<br>3. Agrarian economy<br>4. Technology & physics<br>5. Horticulture<br>6. Breeding of horticultural crops<br>7. Phytopathology<br>8. Cattle feed<br>9. Cattle rearing<br>10. Poultry rearing<br>11. Plant breeding<br>12. Agr. mechanics<br>13. Soil cartography<br>14. Biology and chemistry<br>15. Food processing<br>16. General services<br>17. Soil fertility<br>18. Agr. construction<br>19. Application of nuclear energy in agriculture<br>20. Variety research<br>21. Publication & documentation | 1.Phytopathology inspection<br>2.Veterinary inspection<br>3.Land reclamation | Coordinating commissions for:<br>1. Soil pathology<br>2. Plant regulators<br>3. Weed control<br>4. Soil tillage<br>5. Mineral supply<br>6. Sheep rearing<br>7. Milk quality<br>8. Plant therapy<br>9. Soil biology<br>10. Potato nematodes<br>11. Integrated pest management<br>12. Mushroom domestication<br>13. Veterinary<br>14. Ergonomics<br>15. Cattle feed<br>16. Irrigation with waste water<br>17. Food proecessing<br>18. Pastures<br>19. Documentation & information<br>20. Analytic equipment<br>21. Phytotrons<br>22. Administration<br>23. Cost-benefit of research | 62 professors<br>15 named professors<br>18 lecturers |

The effect of these developments was a ramification of agricultural research over experiment stations, research institutes and laboratories of the Agricultural College. The Directorate Agricultural Production, Processing and Marketing guided the experiment stations and the Extension Service, the Directorate of Agricultural Research steered the research institutes, and research activities at the Agricultural College were conducted by the Permanent Commission on Research. The two directorates were part of the Ministry of Agriculture, the permanent commission was included in the organisation of the Agricultural College. The National Council for Agricultural Research of the TNO organisation contained several commissions that had to integrate the research activities in various fields and on various levels.

## Conclusion

The organisation of agricultural research in the Netherlands developed in the second half of the twentieth century into a layered structure, divided over the departments and laboratories of the Agricultural College, the research institutes and the experiment stations. The driving force behind this organisational differentiation was the idea that true scientific research had to be pure or fundamental, mainly implying that interference with practical issues and contact with agencies outside academia were kept out of the organisational format. The traditional distinction between fundamental and applied research only covered two categories and when from the end of the 1960s the differentiation over three organisational layers was established, a third category of research emerged, mostly coined "strategic research". Research performed at the Agricultural College was a combination of fundamental and strategic research. The research institutes, from about the 1980s denoted as DLO institutes, after the abbreviation of the coordinating directorate (*Directie Landbouwkundig Onderzoek)* performed strategic research. The work at the experiment stations was coined practice research (*praktijkonderzoek*). Classifications always have their borderline cases and anomalies and especially policy reports dealing with the organisation of agricultural research introduced combinations like 'fundamental-strategic research', and border-categories like 'targeted-fundamental research'.[110] The idea behind this division of agricultural science was to create a hierarchical structure in which the highest level of agricultural research would match the idea of scientific research as performed at universities.

In the history of agricultural research the idea of 'real' scientific research as a pure, fundamental and independent activity was primarily pushed forward by university professors, mainly biologists. The most ardent advocates of 'real' science presented in this chapter were M. Treub, F.A.F.C. Went and V.J. Koningsberger, three generations of biology professors who openly and actively tried to push agricultural science in directions where research activities were well protected and fenced off from issues, problems and ideas emerging from practice, as pushed forward by non-scientists, like administrators, farmers or plantation owners. What has become clear in this chapter is that Treub and Went primarily tried to defend their position in relation to the organisation of agricultural research

[110] For example: Directie Landbouwkundig Onderzoek, *Tactisch en strategisch onderzoek: Interimrapport van de Commissie "Verhouding toegepast en gericht - fundamenteel onderzoek."*

in the Dutch East Indies. Treub tried to protect the research activities at the colonial Department of Agriculture from the issues and problems the colonial administration considered as most urgent. Went supported Treub in this and tried to convince planter organisations that their experiment stations should be set up in that direction as well. In their eyes the influence of representatives of the Wageningen institution should be minimised, first of all because they were no real academics and secondly because they considered a mixture of science and practice as workable and even fruitful. The ideas of Treub and Went did not get a foot on the ground in the colonies. A distinction between fundamental and applied science was not considered a workable format. University graduates and Wageningen graduates worked together in the research divisions of the Department of Agriculture and the private experiment stations. The attempt of V.J. Koningsberger in the 1930s to make again a division between fundamental and applied research in the organisation of agricultural science was resisted resolutely. Koningsberger had much more success on that matter in the Netherlands. The commission he chaired in the early 1960s can be considered the breeding ground for the division of agricultural research described above.

There are two elements in the organisation of agricultural science in the Netherlands that made the work of the commission chaired by Koningsberger successful, where he failed to get his ideas implemented in the colonies. The first was the existence of the Agricultural College. From the moment the education institute in Wageningen was included in the academic system the idea to distinguish between the research of the college and the research of the institutes and experiment stations came up. One of the earliest expressions of this came from A.H. Blaauw, student of Went and professor in plant physiology in Wageningen. In other words, the division between various levels of research was latently present in the organisation of agricultural science since 1918. In the Dutch East Indies the differentiation was less easy to distinguish as latent in the various organisational formats. Koningsberger tried to give the Botanic Garden an exceptional status, but in the minds of the researchers, as well as in formal position, the Botanic Garden was merely one of the research institutes next to the others. The second factor that was conducive for the implementation of the plans of the commission chaired by Koningsberger in the 1960s was the resistance of the Directorate of Agriculture to integrate the agricultural research institutes and experiment stations in the national organisation for Applied Natural-scientific Research, TNO. Although one can only argue by speculation, it would be interesting to know what would have happened if the agricultural research divisions had been included in the TNO organisation. The fact that the college departments, research institutes and experiment stations were organisationally kept together by the Ministry of Agriculture enforced the tendency to differentiate between the various divisions. In other words, the research performed at the Agricultural College could present itself as fundamental without loosing its agricultural identity only when a clear relation was maintained with divisions that performed the more applied research. The strategy of the Ministry of Agriculture to keep all levels of agricultural research under its umbrella allowed the Agricultural College to develop its academic image.

# 4

# Scientific education for agriculture

## Introduction

At the turn of the eighteenth and nineteenth century the Dutch academic system was fundamentally revised and agriculture became one of the issues to be taken up in the new curriculum. The courses in agriculture the universities offered from 1816 never attracted many students and in another major reorganisation of the Dutch academic system in 1876 agriculture disappeared from the university curriculum. Nevertheless, several university professors showed a clear interest in agriculture during the nineteenth century and most of them were members of an agricultural society. These societies put much pressure on the government to make legal arrangements for agricultural education and to subsidise agricultural schools. The legal arrangement came early 1860s when a new element was added to the Dutch education system, covering various sorts of schools, including agricultural schools. Scientific education for agriculture was part of this new structure too, resulting in a situation that scientific education was offered at schools that did not belong to the system of higher education. That situation was highly disputed and continued to be a major force in the definition of scientific education for agriculture. The national education system not only determined the status of agricultural education but also to a large extent the education programme. Nevertheless, school managers, teachers and professors had various opportunities to steer the programme, and especially the subjects of teaching, in a direction they considered appropriate. Moreover, several other persons, with little direct control over agricultural education, tried to influence the ideas and organisation of scientific agricultural education by making arguments in public, and by other means.

In this chapter the development of scientific agricultural education between the early 1870s and the 1980s is analysed. A central focus in this chapter is on the Wageningen institution, the single place in the Netherlands where scientific education in agriculture was offered. The analysis covers the structuring role of the national education system, the steering forces of school boards, the debates about the curriculum, the organisation of scientific agricultural education, and the resulting education programmes. Moreover, the perception students had of the education and the impact of the courses offered on the career patterns of Wageningen graduates are taken into account. Additional to various written sources the student accounts are extracted from a series of interviews with former Wageningen students, graduating between the late 1920s and the late 1980s. Although the single institution for scientific agricultural education was located in Wageningen, the Dutch colonies are not entirely out of focus. Since 1896 the Wageningen institution offered special education programmes in colonial agriculture and colonial forestry, and until the late 1940s about half of the students coming to Wageningen registered for one of these colonial programmes. The importance of the colonies as a major provider of jobs for Wageningen graduates also makes itself felt in the contributions of several representatives working in the Dutch colonies to the debate about the Wageningen curriculum.

The chapter is divided into three parts. The first part covers the nineteenth century period of scientific agricultural education, or education in 'scientific agriculture' as it was often called at the time. The second part covers the early academic phase, when representatives of the State Agricultural School and the ministerial Directorate of Agriculture made claims for an inclusion of the school in the system of higher education and started reorganising the organisation of the school and its education. The third period starts at the end of the 1940s when it became clear that agricultural experts for the Dutch East Indies were no longer needed. Investments in agricultural science institutes grew, resulting in the appointment of new professors. Student numbers started growing as well, and all these developments sustained major reorganisations of higher agricultural education in the 1960s and 1970s.

## Educating scientific farmers

Most of the events and activities that resulted in the creation of an institution for scientific education in agriculture in the 1870s were a direct result of a series of changes and developments in the Dutch education system starting at the turn of the eighteenth and nineteenth century. In that period the Netherlands was transformed into a unified nation with a centralised system of administration. A proper legal arrangement for education of all sorts and levels was an important issue in government policy, and a number of state commissions were charged with formulation of a new education system. First, arrangements were made for so-called lower education in the early 1800s, covering basic education for the Dutch population in different forms. The prefix 'lower' referred not just to the level of teaching but also to the social status of its pupils. In other words, the law mainly arranged folk schools. Higher education had its own pre-university trajectory, the Latin schools. In 1809 a commission chaired by J.H. van Swinden divided the system in three levels, lower, middle and higher education. The proposal of the commission of Van Swinden was very modern for its time and the stages lower, middle and higher reflected primarily a step-wise augmentation of level and learning trajectory. Middle education, for example, was considered a secondary education of a general kind that was a continuation of lower education and a preparation for higher education.[1] Higher education was the 'finalising' stage that consequently included all sorts of vocational training. The proposal of the commission of Van Swinden was probably too modern for its time and was not

[1] Baggen, *Vorming door wetenschap*, 55-58. Wachelder, *Universiteit tussen vorming en opleiding*, 46.

implemented, although the idea of creating a system for middle education reappeared in various proposals but remained an empty shell until the early 1860s. Another current issue was the inclusion of vocational training within higher education. The commission that prepared the Royal Decree of 1815 covering higher education included all sorts of vocational issues in its report. The courses the commission referred to were "surgery and medical training in Dutch [instead of Latin, HM], medical training for the army, obstetrics, pharmacy, chemistry applied in factories and crafts, veterinary and practical agronomy, mathematics, navigation, surveying and civil engineering, and finally the formation of officers for the navy, military engineering and artillery."[2] In the final text of the Royal Decree this and other passages concerning vocational training were erased. The government, however, did not neglect vocational education entirely but made ad-hoc legal arrangements for several forms of professional training, mostly outside the higher education system. As described in chapter two, an exception was education in agriculture or land-household studies (*Landhuishoudkunde).*

**Vocational education**

The idea to include vocational training within higher education was, as such, not an invention of commissions in the early nineteenth century. For many years universities provided all kinds of professional courses, especially in nautical and military topics.[3] But universities were not the only place where transfer of practical knowledge and skills was provided. Another institution with a long tradition was the guild system in which young apprentices were trained in a wide range of trades and crafts. Early eighteenth century, the government of the Batavian Republic, inspired by the French revolution, perceived the guilds as old and obscure organisations obstructing economic progress. The guilds, however, survived the republican period, but in 1818 King William I settled the hash and abolished the guild system.[4] The decision implied a severe loss in transfer of professional knowledge and skills, and the government tried to compensate with special arrangements for vocational training. At the end of the 1810s it made legal provisions for education in arts and medicine. Technical education for government services, mainly military, was arranged in 1828 and 1829 with the establishment of a Military and a Naval Academy. In 1842 the non-military courses of these academies were transferred to a new institution where engineers for government services, the industry and colonial civil servants were trained (the Royal Academy for civil engineers, in Delft).[5] Parallel to the special arrangements for vocational

[2] Roelevink, "Rapport van de commissie van der Duyn van Maasdam", 46.

[3] Davids, "Universiteiten, Illustre scholen en de verspreiding", 3-34. Verbong, "De uitgangssituatie", 24-41.

[4] Goudswaard, *Vijfenzestig jaren nijverheidsonderwijs.*

[5] Baggen, *Vorming door wetenschap*, 86-90. Lintsen, *Ingenieurs in Nederland in de negentiende eeuw.*

education were initiatives of King William I in the 1820s to introduce professional courses in the universities. The universities in general were not very enthusiastic about this and tried to keep the courses out, but many professors were positive about the idea and informally included all sorts of practical issues in their lectures. Despite the relatively poor reception, the integration of practical issues in university teaching had a considerable effect on the idea of academic formation. Practical issues were not merely accepted but were a central focus for acquiring knowledge and academic teaching. In other words, practice became an integral element of epistemology, resulting in a major shift in the idea of higher education in mid-nineteenth century.[6] The formal arrangement of this change, however, was quite a different matter.

The distribution of vocational education among universities and special academies lasted until 1863. In that year a new law on Middle Education was passed, introducing a new layer in the education system. About sixty years after the first proposals in that direction were made, the government implemented this middle layer in the education system. Although the new law contained many elements of earlier proposals, the law of 1863 deviated at some crucial points. The most important element the 1863 law neglected was the bridging function of middle education between lower and higher education. Consequently, middle education became a separate entity. Responsible for this separation was the driving spirit behind the law, the liberal minister, J.R. Thorbecke (1798-1872). In his idea the distinction between middle and higher education was not gradual, but reflected a fundamentally different social and pedagogical order.[7] Students entering middle education however should have the opportunity to get education of a scientific level as well, which should be provided by the Royal Academy in Delft (renamed Polytechnic School) and an Agricultural School, to be established. The division between middle and higher education met fierce resistance in parliament, but Thorbecke managed to get the law passed. The implication for scientific education was that there were now two forms, one taught in institutions of middle education and the other at the universities.

For agricultural education the Middle Education Act implied a legal arrangement for schools that offered such education on three levels. The lowest level was education of techniques and basic principles of agriculture, included in schools for other forms of technical education. The arrangement for the second level was agricultural education in special schools, preferably founded by private agencies, and the third level was a State Agricultural School offering 'study and science of agriculture'.[8] Another important consequence of the law was that scientific agricultural education was not considered an issue for universities. Initially, the

[6] Baggen, *Vorming door wetenschap*, 101-116.

[7] Ibid. Boekholt en de Booy, *Geschiedenis van de school in Nederland*, 179-211.

[8] Van der Poel, *Het landbouwonderwijs*, 91.

new law proposed to create two State Agricultural Schools. The parliament, however, accepted an amendment, handed in by the president of the Dutch Society of Agriculture (*Hollandsche Maatschappij van Landbouw*), W.C.M. Begram, stating that "there will be a State Agricultural School when the need for agricultural education is not provided otherwise."[9] The motive for handing in the amendment was the protection of the School for Land-household Studies (*Landhuishoudkundige School*) in Groningen, which aspired to transform itself into State Agricultural School. The main government adviser, W.C.H. Staring (1808-1877), considered the school in Groningen of low quality however. His perception of the quality of the school in Groningen brings us to the heart of a fierce discussion on agricultural education going on in the Dutch agrarian community in the 1860s.

**Agricultural societies and science**

The dispute of the 1860s on agricultural education was by and large a conflict between the government and the agricultural societies. The source of the conflict was in fact a legacy of the Royal Decree of 1815, arranging higher education in the Netherlands. Part of the Decree was an arrangement for chairs in land-household studies, *landhuishoudkunde*, intended for theology students, with the idea that many future preachers would get a post in farming communities. The Dutch Reformed Church, however, considered agriculture not as a crucial element in studying religion, and managed to lift the compulsory status of the lectures in the late 1820s. The number of students attending the courses dropped very quickly. Therefore the professors in land-household studies, enthusiastic about their assignment and their income depending on study fees, convinced the government to open up the lectures to the public, included in the law in 1840. Especially in Groningen, where H.C. van Hall (1801-1874) was appointed in 1826, the lectures were well attended.[10] Van Hall used the success of his lectures and his position as secretary of the Dutch Society for the Advancement of Industry to expand agricultural education. Having heard of the government plans to create an academy for civil engineering, Van Hall, supported by representatives of other societies, requested the King to locate the new academy in Groningen. But negotiations with the city of Delft were already going on and the request was refused. Therefore the Groningen people decided to create an agricultural school themselves. The involvement of Van Hall guaranteed an academic input where the support of the societies implied the purchase of a farmstead and a piece of land.

The school in Groningen was supported by the agricultural societies, united in the annual congress (*Landhuishoudkundig Congres*). In 1849 the congress installed a special commission, chaired by W.C.H. Staring, that had to report about

[9] Cited in: Goudswaard, *Agrarisch onderwijs in Nederland*, 116.

[10] Goudswaard, *Agrarisch onderwijs in Nederland*, 101-106. See also chapter 2.

options for the creation of agricultural schools.[11] The commission made recommendations in line with the existing structure of lower and higher education, and advised for agricultural education of both levels. "[B]ut we hasten to say, that in both cases, practice and theory, in other words: cultivation and science, have to go hand in hand, yes are inseparable, if any of the two will be of value."[12] As agriculture was already a teaching subject on the universities, the congress' main concern was to create schools where young farmer sons with varying intellectual capacity could enter. Some would only follow the lower level training where others entered scientific education and might even continue at the university. The initiatives of van Hall in Groningen were therefore considered as exemplary.

The addresses and requests the congress and individual societies sent to the king did not entirely fall on deaf ears. In 1856 the king assigned a commission to inquire into the need for agricultural education and to make proposals for the arrangement of such education. The commission, chaired by G.J. Mulder, professor of chemistry in Utrecht, and including among its members W.C.H. Staring and H.C. van Hall, made a report containing a detailed description of what an agricultural school should look like. What they envisioned was a school in the countryside, close to a city with a university, preferably in the middle of the country where different soil types could be found within close distance. The education should contain all relevant elements of the natural sciences, but equally important were practical course elements. "Just as it is true, that the natural sciences cannot be known only by lectures in the auditorium and book study, such is equally true in large extent for agriculture. To know this science profoundly, there has to be familiarity with work in the field, as well as written experience of different peoples, from later and earlier periods."[13] In sum, an integration of theoretical and practical course elements was a common feature of the various pleas and reports that were written in the late 1840s and 1850s. The Middle Education Act of 1863, however, cut across the overall consensus on the character of agricultural education.

In 1861, a year before Thorbecke became cabinet leader for a second period, Staring was asked by the government to make a trip around Europe to inform about the arrangement of agricultural education. His advise was basically the same as what he had proposed together with Van Hall and others, with the exception that he anticipated the new law of 1863, so agricultural education should also stretch over lower, middle and higher education.[14] As described in the previous section, Thorbecke held a different opinion on that. Not only did he consider higher education as something to which mundane activities like agriculture should not belong, but he thought any level of agricultural education

[11] Staring, *Over de oprichting eener Nederlandsche Hoogeschool voor den landbouw.*

[12] *Verslagen Landhuishoudkundig Congres* (1849), 53.

[13] Mulder, *Verslag aan den Koning*, 11.

[14] Staring, *Verslag over de landshuishoudkundige school te Groningen.*

should refrain from activities like "the manual labour, the ploughing, sowing and pruning."[15] In his view hands-on practical courses did not belong in any school in the system of middle education and therefore he saw no reason to attach farms to agricultural schools. This view met fierce criticism from the agricultural societies and also implied a difficult position for the school in Groningen created by Van Hall. Moreover, Thorbecke appointed Staring as one of the three national Inspectors for Middle Education. Staring's assignment included the inspection of agricultural education, and from that position he drew the conclusion that the school in Groningen was performing very badly both on the intellectual and the financial side. This led to sharp conflicts between Staring and van Hall and the closure of the Groningen school in 1871.[16] So in the end the formulation of the Middle Education Act and the compliance by Staring resulted in a situation with no institution where scientific agricultural education was provided. That, however, changed in 1876.

### A school of compromise

The State Agricultural School (*Rijkslandbouwschool)* arranged by law in 1863 was ultimately established in 1876 in Wageningen, a town in the province of Gelderland, about twenty kilometres west of Arnhem. The delay of thirteen years between the act providing for the school and the opening of the State Agricultural School was a result of several deficiencies in the Middle Education Act. The law arranged various school types, the courses these schools had to offer and the requirements for teachers. Teachers should have a teaching certificate in Middle Education, *MO-akte*, specified for certain courses and acquired at a university or by special adjudication. Regarding the certificate for agricultural courses, the law stated that it was received by graduation at the State Agricultural School, a school not yet existing. Moreover, agricultural issues were not taught at the universities and the few qualified by adjudication, like van Hall, were near retirement. Another problem concerned practical courses, a problem not only present in agricultural education, but also obstructing the functioning of another school type arranged by the law, the *Burgerschool*, the secondary school for the working class. In these schools hands-on practical education was not allowed in the programmes and therefore these schools did not attract many students from the social groups it was intended for. Moreover, city administrators and industrial firms started to finance special schools where the vocational training did include instruction in manual skills.[17] Early in

[15] Cited in: Goudswaard, *Agrarisch onderwijs in Nederland*, 114.

[16] Velding, *W.C.H. Staring;1808-1877*, 83-116. Goudswaard, *Agrarisch onderwijs in Nederland*, 136-141.

[17] Goudswaard, *Vijfenzestig jaren nijverheidsonderwijs*, 253-259. Boekholt en de Booy, *Geschiedenis van de school in Nederland*, 200-205.

the1870s the inspectors for Middle Education created options to circumvent these problems.

After the death of Thorbecke in 1872 the school inspectors applied a more flexible interpretation of the Middle Education Act. The government subsidised schools and allowed them to profile themselves as schools of Middle Education without meeting all legal requirements. Consequently, the municipality of Wageningen, together with representatives of the agricultural society of Gelderland, made arrangements to start with agricultural education. In consultation with M. Salverda (1840-1886) who succeeded Staring in 1873 as inspector, a programme in agricultural education was attached to the *Hogere Burgerschool*, the school type of the Middle Education Act that was most successful. The school managers persuaded the German agronomist J.O.F. (Otto) Pitsch (1842-1939) to come to Wageningen for the teaching. After three years, the director of the Wageningen school, D.J. Andreae, Salverda and the responsible minister J. Heemskerk, agreed to transform the agricultural course into a State Agricultural School (*Rijkslandbouwschool*), to provide scientific agricultural education.[18] This arrangement was only possible with a broad interpretation of the Middle Education Act, but the inspectors were rather strict regarding the qualification for teaching.

Already in 1870 the government invited Otto Pitsch to do an examination for the teaching certificate, *MO-akte*, in agriculture. Pitsch, who received his doctorate *cum laude* at the German agricultural academy of Poppelsdorf, was insulted by the invitation but in the end agreed to give an informal *colloquium doctum* with (among others) Staring and Salverda in the judging-committee. For several years he was the only person in the Netherlands with a *MO-akte* in agriculture. In 1874 the government tried to speed things up by offering study grants for acquiring the certificate at one of the German agricultural academies. Out of three hundred applicants initially five were selected. Two of them, L. Broekema (1877) and F.J. van Pesch (1876) were indeed appointed as teacher at the Wageningen school.[19] For more general teaching subjects, like botany or physics, university graduates were appointed but the school did not have certified teachers for all courses prescribed in the law. As a result, students of the Wageningenschool could not be examined in all subjects and therefore did not receive the *MO-akte* in agriculture by graduation. To become a qualified agricultural teacher for Middle Education, additional study at a foreign agricultural academy was required. This situation lasted until 1904.

Regarding the hands-on practical courses in agriculture, the State Agricultural School was given more freedom, best illustrated by the appointment of its first director, C.J.M. Jongkindt Coninck (1834-1885). Jongkindt Coninck graduated in

[18] Roussingh, "Schets van het ontstaan", 173-194. Goudswaard, *Agrarisch onderwijs in Nederland*, 142-150. Van der Haar, *Geschiedenis I*, 44-45.

[19] Van der Poel, *Het landbouwonderwijs*, 100-104.

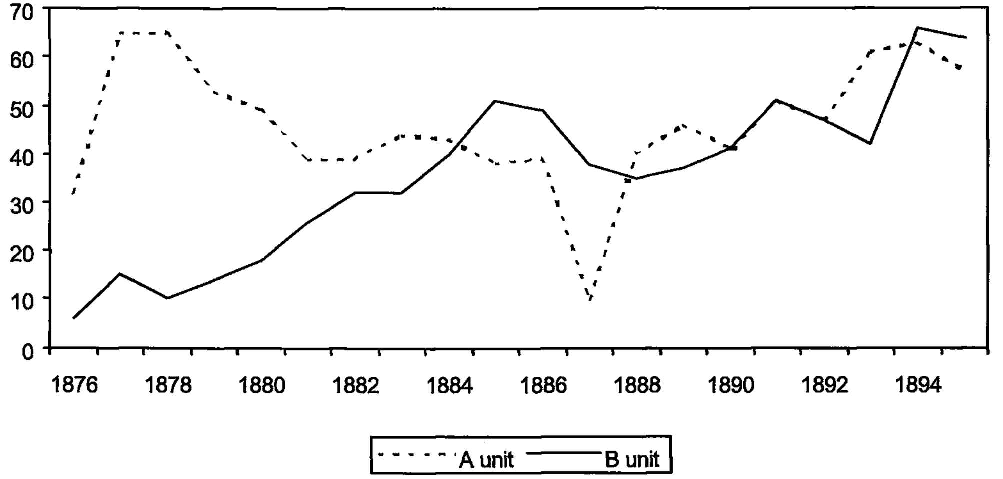
1853 at the agricultural school in Groningen. After five years of work on different large farms he returned to the Groningen school to teach and carry out administration.[20] His appointment as director of the school in Wageningen must be considered a gesture to the agricultural societies. Not only his background at the Groningen school, on which Salverda shared Staring's negative judgement, but also the fact that Jongkindt Coninck spent most of his career as manager of large farmsteads demonstrates that. Moreover, once appointed, he started a lobby for building a model farm at the *Rijkslandbouwschool* - successfully, as the *Duivendaal-hoeve* was opened in 1880. The government probably hoped that the position of Jonkindt Coninck would take the sting out of the conflict over courses in practical skills. But the main reason for the agricultural societies to plead for manual experience was to educate and train future farmers. And that was where representatives of the farming community judged the performance of the State Agricultural School.

## Profiles of Wageningen graduates

The State Agricultural School opened in 1876 was in fact an organisational shell for three types of education, all part of the system for middle education. The first element was a continuation of the programme started in 1873, offering agricultural education of the middle level. This unit was called the A-department. The B-department was a two year programme, offering scientific agricultural education. The third unit was a secondary school, *Hogere Burgerschool,* offering general education qualifying for the agricultural programmes or other vocational schools. Besides these teaching units, the State Experiment Station, (*Rijkslandbouwproefstation*), opened in 1877, was also part of the organisation, although it had its own director.

[20] Van der Poel, "C.J.M. Jonkindt Coninck (1834-1885) de eerste directeur", 396-403.

**Figure 1: Student numbers State Agricultural School Wageningen, A and B unit, 1876-1895. (Source: Programma van onderwijs.)**




Every year the school published a booklet that served both as study guide for the students and as an annual report for a wider public.[21] In the first year the A-department counted thirty-six students and the B-department six. After five years student numbers in both divisions were more or less equal.The school started with sixteen teachers; five of them had a doctorate and one a law degree.[22] As the school intended to educate future farmers , the background of the students was a recurrent issue in the annual overview. "As a very fortunate phenomenon can be mentioned that not only those whose later destination may not be agricultural practice, but especially the sons of developed farmers formed the main contingent of students that now attend the Rijkslandbouwschool."[23] The author, director Jonkindt Coninck, seems rather satisfied about the performance of the school, but the positive tone did not last for long. Over the year 1878 the director expressed his worries over the low participation by farmer's sons in the Wageningen education. "People are apparently not aware that: 1) more knowledge and broad education lead to more prosperity for the farmer as for anyone else; 2) the future farming community should no longer be withheld from the development that is part of those who are educated in other scientific professions."[24] Student numbers were rising but the number of

[21] *Programma van het onderwijs.*

[22] *Programma van het onderwijs* (1877-1878), 1-2.

[23] Ibid., 42.

[24] *Programma van het onderwijs* (1879-1880), 59.

students from farming families was apparently low, although no clear figures are at hand.

The State Agricultural School not only expanded in student numbers. In 1882 former Inspector of Agriculture from the Dutch East Indies, K.W. van Gorcum, agreed to lecture on colonial agriculture, in addition to the regular programme. On a similar basis other teachers were attracted to teach issues like land surveying, bee culture and forestry. The lectures in colonial agriculture and forestry were transformed into full programmes in 1896. In the same decade the government set up an extension service, increased the number of agricultural experiment stations and invested in agricultural schools all over the country. All these elements resulted in a diversifying profile of the 'output' of the *Rijkslandbouwschool*.[25] This expansion of the school in quantitative and qualitative senses resulted in a name change. The A-department was renamed Agricultural School (*Landbouwschool*) and the B-department in Higher School for Agriculture and Forestry (*Hogere Land- en Bosbouwschool*). The change in name did not yet imply a change in the general objective. The Higher School was intended for "farmers who want scientific education, for future administrators of possessions in the Netherlands and the Indies."[26] A major reason for this was the influence of the agricultural societies on government decisions concerning agriculture, illustrated by the opinion and activities of one man, C.J. Sickesz(1839-1904).

In 1898 a Directorate of Agriculture was added to the Ministry of the Interior and the first Director-General of Agriculture in the Netherlands was C.J. Sickesz Before he became DG he had been leading various agricultural commissions and organisations, like the Agricultural Society of Gelderland (*Geldersche Maatschappij van Landbouw*). In Sickesz' view the *Rijkslandbouwschool* did not meet the demand for agricultural education.[27] He based this conclusion on the fact that the large majority of the Dutch farms did not exceed twenty hectares. The school in Wageningen did not serve these farmers, because the education level, as well as the school fees ,were too high for them. Sons of large-landowners would prefer the university for proper education and in result the majority of the Wageningen graduates went to the Dutch East Indies. "More than 4 agriculturists per year, supposing that they were real farmers, cannot be counted."[28] Sickesz supported his argument with some figures. From a sample of 147 students he counted 19 whose parents were farmers. Therefore Sickesz proposed to "make from Wageningen a school for pure technical education and bring the higher education where it belongs and where it will find its students, at a university (...)."[29] Many prominent figures in

[25] See chapter 3. Van der Haar, *Geschiedenis I*, 53-74.

[26] *Programma van het onderwijs* (1896-1897), 64.

[27] Sickesz, *Voldoet de Rijkslandbouwschool te Wageningen.*

[28] Ibid., 8.

[29] Ibid., 11.

the farming community agreed with Sickesz' analysis, but not everyone shared his judgement. D.R. Mansholt, for example, a farmer and breeder from Groningen, argued that because Wageningen did not attract many farmer sons did not imply the school did not serve a purpose. In his view the education in Wageningen simply prepared students for other jobs than farming and with reason. "For education in practical farming the teachers in the different branches of agricultural science are not half as competent as the most simple farmer and the best equipped school less suited than the most primitive farm."[30] According to Mansholt, the Wageningen school is a valuable institute in its own right "that can stand the comparison with the best of similar foreign institutes."[31]

**Table 1: Courses State Agricultural School, second year, B-unit, 1880-1881. (Source: *Programma van het onderwijs*.)**

| Course | Teacher | Hours/week | |
|---|---|---|---|
| | | Lectures | Lab |
| Mathematics | J. Jurling | 2 | |
| Mechanics | D.H. te Wechel | 2 | |
| Physics | J. van Dam | 3 | |
| Chemistry | dr. A. Mayer & G. Reinders | 3 | |
| Mineralogy & Geology | G. Reinders | 2 | |
| Botany | dr. M.W. Beijerinck | 2 | |
| Zoology | dr. J. Ritzema Bos | 4 | |
| Economics | mr. W. Reilingh | 2 | |
| Agric. chemistry | dr. A. Mayer | 3 | 5 |
| Crop science | L. Broekema | 2 | |
| Cattle breeding | L. Broekema | 2 | |
| Dairy farming | L. Broekema | 1 | |
| Agric. machinery | S. Lako | 2 | |
| Book keeping | S. Lako | 1 | |
| Farm economics | dr. O. Pitsch | 1 | |
| Soil tillage | dr. O Pitsch | 1 | |
| Veterinary medicine | H.C. Reimers | 1 | |

In the years around the turn of the century many things changed. In 1901 Sickesz resigned from office at the ministry, for health reasons. In the same year the study guide stated that the Higher Agricultural and Forestry School was "intended for the education of scientifically formed agriculturists (*landbouwkundigen*) both for the

[30] Mansholt, *De reorganisatie der Rijkslandbouwschool*, 9.

[31] Ibid., 14.

Netherlands and the Dutch East Indies.'[32] The major difference between this formulation and that of previous years is that any reference to the social background of the students was lacking. As Mansholt rightly observed, the Wageningen education served the agrarian sector in a different way than by training 'scientific farmers'. Transfer of knowledge, skills and technologies to the farming community was primarily a matter for the Agricultural Extension Service (*Landbouwvoorlichtingsdienst*), the agricultural experiment stations and lower-level agricultural schools. A major function of the Wageningen school became providing competent agriculturists for these services. In the first two decades of the twentieth century, the school was not only transformed to perform that task properly, but it was also pushed from the system of Middle Education to the system of Higher Education, implying a new phase in the discussion of the education offered in Wageningen.

## Higher Agricultural Education

The changes in the education profile of the State Agricultural School at the turn of the nineteenth and twentieth century not only concerned graduates leaving the school, but also the intake of first-year students. The official requirement for entering the Wageningen institution was a certificate of a three-year *Hogere Burgerschool*. The Middle Education Act law provided for three- and five-year versions of this secondary school for 'higher civilians', being two different school types. A three-year version was included in the organisational structure of the State Agricultural School (*Rijkslandbouwschool*). In the reorganisation of 1896 the requirement for new students was raised to a certificate of a five-year *Hogere Burgerschool*.[33] This decision must be understood in relation with two other developments. First of all, the three-year version of the secondary school was not very successful, in the sense that only a small number of such schools were established, in comparison to the five-year version. Consequently, the number of students with an official and optimal connection between the secondary and tertiary phase was relatively low. Secondly, many students leaving the five-year version of the *Hogere Burgerschool* tried to enter one of the universities. Although the law had drawn a clear line between middle- and higher education, universities accepted these students on the basis of additional examinations. In other words, the *Hogere Burgerschool* became an illegitimate but tolerated type of pre-university education. This indirectly implied that the Polytechnic in Delft as well as the *Rijkslandbouwschool* in Wageningen lost their exclusiveness in offering scientific education in the system of middle education. The

[32] *Programma van het onderwijs* (1901-1902), 133.

[33] Van der Haar, *Geschiedenis I*, 79-94.

two institutions were well aware of that and anticipated academic status in various ways.[34] The official recognition came in the early 1900s.

## A new formal structure

The responsible minister for the change in the Higher Education Act, A. Kuyper (1837-1920), disagreed with the idea formulated by Thorbecke that higher education was the exclusive domain of universities. "This conflicts with the development of modern live, that does not tolerate such a restriction of the field of science, and requires scientific research, as well as scientific researchers, for every principle of life and social activity."[35] Kuyper however did not want to put simply all forms of scientific education together and distinguished between universities "that teach the whole of sciences in its unity" and colleges (*hogescholen*) that "teach higher education, but aim scientific research on a piece of social life of a particular kind."[36] The amendment, enacted in 1905, included the change of the Delft Polytechnic into a *Technische Hogeschool* and further stated that separate legal arrangements would be made for an Agricultural College and an Economic College. Similar to the situation in 1863, agricultural societies from Groningen tried to influence the process and an ally in parliament amended Kuyper's proposal to leave open the option of a faculty for agricultural science at the Groningen University. The result was a vague formulation and the 1905 version of the Higher Education Act stated that "separate legal arrangements will be made for higher agricultural education and higher economic education".[37] But unlike the situation in 1863 higher agricultural education already existed, at least in the view of the school in Wageningen. The institution was backed by the new Director-General of agriculture.

H.J. Lovink (1866-1938) succeeded Sickesz as head of the Directorate of Agriculture in 1901. The Directorate moved from the Ministry of the Interior to the Ministry of Public Works, Trade and Industry. Lovink put much effort in the improvement and expansion of the various government services for agriculture. One of his concerns was the education of qualified agricultural teachers. In the early 1900s it was still not possible to acquire a teaching certificate for agriculture in the Netherlands. The most obvious candidates, graduates from the Higher School for Agriculture and Forestry (*Hogere Land- en Bosbouwschool*) had to go abroad for an academic degree in agriculture, a costly enterprise. To increase the supply of qualified teachers Lovink reorganised the school in Wageningen in such a way that all courses required for the teaching certificate were examined. The operation was

[34] Baggen, *Vorming door wetenschap*, 137-143.

[35] Cited in: Addens, *Vereeniging voor hooger landbouwonderwijs*, 84.

[36] Ibid.

[37] Addens, *Vereeniging voor hooger landbouwonderwijs*, 79-91.

finished in 1904 and the school again received a new name, State Higher School for Agriculture Horticulture and Forestry (*Rijks Hogere Land-, Tuin- en Bosbouwschool*). The three-year programme was extended with an extra year for specialisation, including a course track leading to the teaching certificate. In the eyes of the Directorate of Agriculture, the State Higher School now was ready for the academic system. "Although the institution for this type of education belongs to the schools of which the organisation is provided by the Middle Education Act, it has entirely the character of a *hogeschool* and that is why the education it offers can be considered as higher agricultural education."[38] In line with the changes in the programme, the organisational structure was reformed in two phases. In 1904 the *Hogere Burgerschool* continued as an autonomous secondary school. In 1912, the former A-unit, in 1896 renamed in Agricultural School, was split up over two separate schools. The programme for Dutch agriculture was transformed into an agricultural school in Groningen and the colonial programme was moved to Deventer and continued as school for colonial agriculture. The main architect behind these plans was Lovink, although he exchanged the leadership over the Directorate of Agriculture for the same position in the colonial Department of Agriculture in 1909.[39] A major target of the reorganisation was to include the Wageningen institution in the system of higher education, and this was reached in 1918, once more including a name change from 'State Higher School' into Agricultural College (*Landbouwhogeschool*). Like the graduates from the Technical College in Delft, Wageningen graduates received the title (agricultural) engineer (*landbouwkundig ingenieur*). In 1918 Lovink returned from the Dutch East Indies and became a member of the board of trustees of the Agricultural College, a position he retained to his death in 1938.

**Rising demand for agricultural researchers**

The restructuring of the Wageningen institution in the 1900s and 1910s was driven by the academic aspirations of the school, but the ambition fitted very well in support of another objective of the education facility in Wageningen. The school was part of a number of other government services for agriculture, services that were growing in size and number, resulting in a growing demand for qualified agricultural experts. Moreover, in the late nineteenth century and early twentieth century various agricultural companies and cooperatives were established, requiring qualified agriculturists as well. The Wageningen study guide reflects this growing and diversifying demand for experts, and in 1905 a new prospectus is offered of scientific agricultural education in Wageningen. "It offers the opportunity for sons of large-landowners, more well-off farmers and large breeders to form themselves scientifically and to acquire the knowledge of agriculture, horticulture and forestry

[38] Directie van den Landbouw, *Een en ander*, 12.

[39] Van der Haar, *Geschiedenis I*, 102-117. Van der Poel, "Lovink, Hermannus Johannus", 262-263.

that their future position in society requires. Furthermore it is intended for the education of employees required by the State, societies and private enterprises to look after its interests and for practising agriculture in the widest sense, like agricultural advisors, horticultural advisors, teachers for agricultural and horticultural schools, dairy advisors, cattle advisors, assistants, chemists and agriculturists for research stations, state officials in our country and the Dutch East Indies, officials for the Heath-Reclamation Society (*Heidemaatschappij*), employees for agricultural and industrial companies in our country and our colonies, administrators of estates, etc."[40] Besides the various functions, the original objective of the school, offering scientific education to farmers, is still mentioned. But unlike the first decades of the school's existence, early twentieth century the discussion about the Wageningen education was dominated by the rising demand for researchers and analysts in the various private and public laboratories in the Netherlands and its colonies.

In the 1890s the Dutch government established various agricultural experiment stations (*landbouwproefstations*). These stations were supposed to perform analyses of various agricultural products for quality control and prevention of fraud. Besides, the station had to perform research activities associated with all sorts of improvements. In the nineteenth century the emphasis was on test and control activities but in the early twentieth century research became more important. But sampling and control analyses did not diminish, on the contrary. To prevent control activities consuming all the time of the station workers, the Directorate of Agriculture decided in 1907 to split control and research activities into separate divisions. "[A]t each station a division of different departments with its own personnel was established, in which the agricultural research and the control activities were strictly separated."[41] As the measure appeared not to work very well, the Directorate decided in 1915 to split the different activities over various stations, resulting in control stations and research stations.

Another important development in the first decades of the twentieth century was the creation of agricultural research institutes. In the Netherlands these institutes were attached to the school in Wageningen. In the Dutch colonies similar institutes were created in the 1900s and 1910s as well, with the difference that many of these institutes were funded by private planter organisations and that they mostly performed research, agricultural experimentation and control analyses, where in the Netherlands these functions were differentiated over various institutes. The creation of these research institutes implied more job opportunities for Wageningen graduates in research. The new institutes in Wageningen also implied a closer connection between research and education. The directors of the research institutes lectured at the school in Wageningen and made students acquainted with research work. A growing emphasis on research activities in the education was not a

[40] *Programma van het onderwijs* (1905-1906), 15.

[41] Hissink, "Reorganisatie van het proefstationswezen", 13.

peculiarity of agricultural science but a general phenomenon in Dutch academia of the early twentieth century.[42] As demonstrated in chapter three, this was certainly not a silent change. University professors like F.A.F.C Went directly or indirectly denounced the shortcomings of the Wageningen graduates in that respect, invoking biting responses from Wageningen representatives such as J. Ritzema Bos. Much of the debate was about where researchers were educated instead of what they were taught. However, the ideas about the right preparation for agricultural research work varied among Wageningen teachers as well. A good example is the short but turbulent career of Z. Kamerling at the State Higher School for Agriculture, Horticulture and Forestry in Wageningen.

### A conflict over lab experience

Zeno Kamerling graduated at the Wageningen school in 1892 and continued studies at the universities of Amsterdam, Jena, where he received his doctorate, Munich and Berlin. In 1899 he went to the Dutch East Indies, where he worked at the West Java Sugar Experiment Station and subsequently was appointed as director of a sugar research station in Brazil. Besides his research work he was active as a journal editor and teacher at a school in Batavia. He returned to the Netherlands in 1913 and worked for a year at the university of Leiden, before he was appointed as teacher in tropical perennial crops at the State Higher School for Agriculture, Horticulture and Forestry in Wageningen.[43] In his inaugural address Kamerling broached the subject of education of scientific researchers. "For the future colonial agronomist it seems to me that learning to experiment, learning to observe, learning to research, is of much greater value then studying lecture notes and textbooks [...]."[44] According to Kamerling the curriculum contained far too much lecturing and far too little laboratory training. "The result is that to study becomes believing from authority instead of understanding, and to a similar extent the interest to form a judgement from own observations and own research will be lost."[45] The alternative he presented is a curriculum set up in three stages. The first step is an introductory year providing basic scientific insights necessary for the second stage of general professional education. The third stage is that of specialised training in different subjects and preferably completed with a dissertation. Kamerling thought that his rearrangement resulted in a better programme, left more options for students from other schools to proceed in Wageningen, gave Wageningen students the opportunity to do their specialised study somewhere else, or to leave the school after completing the professional phase. Moreover he made a distinction between

[42] Hutter, "Nederlandse laboratoria 1860-1940", 150-174. Baggen, *Vorming door wetenschap*, 122-137.

[43] *Archive Lh*, 10 and 441.

[44] Kamerling, *De groote problemen der koffie kultuur*, 145.

[45] Kamerling, *De Rijks Hoogere Land-, Tuin-, en Boschbouwschool te Wageningen*, 23.

compulsory and optional courses and proposed to have each study programme organised in separate structures, similar to university faculties.[46]

Kamerling clearly considered research experience as one of the major aims of the education of the Wageningen institution. The only person who replied in public to his writings was Otto Pitsch. His response was a lengthy exposé about university education, emphasising elements like character formation and the great value of the unity of the sciences, something that in his view can never be achieved when focusing on specific subjects such as agriculture. Pitsch's main message was that any deviation from the ideal university is a surrogate and in that light the Wageningen curriculum was not as bad as presented by Kamerling. According to Pitsch things would be even better once the school had university status and a larger budget.[47] Pitsch did not really object to the points made by Kamerling and primarily criticised him on his blunt formulations. Besides the limited response to Kamerling's proposals, his ideas and position in the debate cannot be entirely disconnected from his conflict with the school board over his appointment.

[46] Ibid. Kamerling, "Wat het Onderwijs aan de Rijks Hoogere Land-, Tuin- en Boschbouwschool is."

[47] Pitsch, "Opmerkingen naar aanleiding", 149-174.

**Table 2: Courses in the 2nd year of the State Higher School for Agriculture, Horticulture and Forestry, 1915-1916. (Source: *Programma van het onderwijs*)**

| Dutch Agriculture | Teacher | Hrs per week Lec | Lb | Colonial Agriculture | Teacher | Hours per week Lec | Lab |
|---|---|---|---|---|---|---|---|
| Mathematics | dr. M.J. van Uven | 2 | | Mathematics | dr M.J. van Uven | 2 | |
| Botany | dr. E. Giltay | 2 | 1 | Botany | dr. E. Giltay | 1 | 1 |
| Design and construction | A.M. Kuysten | 1 | 2 | Land surveying | E.J. Kempees | 2 | |
| | | | | Design and constr. | A.M. Kuysten | 1 | |
| Agric. machinery | S. Lako | 1 | | Agric. machinery | S. Lako | 1 | |
| Soil tillage | dr. O. Pitsch | 1 | | Soil tillage | dr. O. Pitsch | 1 | |
| Soil improvement | S. Lako/J. Elema | 2 | | Agric. chemistry | J.H. Aberson | 3 | 5 |
| Agric. chemistry | J.H. Aberson | 3 | | Crop science | H. Mayer Gmelin | 2 | |
| Crop science | H. Mayer Gmelin | 2 | 5 | General agronomy | dr. A. van Bijlert | 2 | |
| Zoology | H.C. Reimers | 2 | | Perennial cultures | dr. Z. Kamerling | 1 | |
| Cattle breeding | L. Broekema | 2 | | Zoology | dr. H.C. Reimers | 1 | |
| Phytopathology | dr. H.M. Quanjer | 1 | | Phytopathology | dr. H.M. Quanjer | 2 | |
| Agrarian law | dr. H. Bordewijk | 1 | | Agrarian law | dr. H. Bordewijk | 1 | |
| Agric. economics | S. Koenen | 2 | | Col. book keeping | dr. A. Berkhout | 1 | |
| Farm economics | S. Koenen | 2 | | | | | |

Kamerling was approached by the school board to teach tropical perennial crops for a period of four years to cover the time needed by the selected candidate, A. d'Angremond, to finish his duties in Java. A few months after Kamerling accepted the interim position he wrote to the board that his agreement with the temporary position was "a slip of the pen" and he put himself forward as a candidate for the fixed appointment. The board rejected his application but several members of the 'council of teachers' suggested that Kamerling might be even better qualified for the position than d'Angremond. The question reached parliament and the minister stated that the current teacher was only a temporary appointment and not really qualified for the job, so he would be replaced by d'Angremond in due time. Kamerling, convinced that the Minister's judgement was prompted by the school board, was furious and demanded in a general meeting of the teachers in March 1917 that the school board make a public statement that he was no less well qualified than other candidates. The request was rejected and Kamerling left the meeting saying that he would offer the minister his resignation by telegram. Several months later d'Angremond sent a telegram from Java also announcing his resignation from the post, without further clarification. The vacant position was filled in 1919 with the appointment of W.J.K. Roepke, former director of the General Research Station of

Middle Java.[48] The connection between the conflict over Kamerling's position and his ideas about the curriculum are clarified by considering the background and career development of the two main figures of the school board.

The leading figures in the school management were L. Broekema and A.H. Berkhout. Broekema was director of the school from 1905 to 1916 and Berkhout was secretary of the board for many years and director in the year 1916-1917. Although Broekema and Berkhout had acquired a stable position in the school management, the incorporation in the system of higher education in 1918 implied a somewhat sad end to their careers. The board of trustees in consultation with the responsible Minister decided which among the teachers of the former school would become professors in the new Agricultural College. The judgement for Broekema and Berkhout was that they were scientifically inadequate. They received a professorship for the years of dedication to the school but on the condition that they would go into early retirement.[49] Especially for Broekema, a well-known wheat breeder and one of the first teachers at the Wageningen institution, this must have been difficult to swallow. The main point, however, is that the idea of higher agricultural education offered by the new Agricultural College differed from the old idea of scientific agricultural education, offered by the State Agricultural School. Kamerling very well expressed the new idea where research capacities were crucial. His formal position, however, was rather weak and his attempts to get a permanent job at the institution appears somewhat clumsy. In any case the timing of his argument was too early, as representatives of the old school were still in charge. The transformation into an Agricultural College, however, did not imply that the discussion initiated by Kamerling ended.

## Research and practice

The professorships granted to Broekema and Berkhout show that an institution with a new profile cannot simply start with a blank sheet. This institutional inertia was also a factor in a more material sense. The decision to include agricultural education in the system of higher education initiated some attempts, primarily from the universities of Groningen and Utrecht to incorporate agricultural science in a new faculty. Although government representatives considered this a serious option, the decisive argument to maintain Wageningen as the location was that investments in the buildings and equipment in Wageningen would make a transfer too costly. Maintaining the location and many of the old teachers also implied that the curriculum was a mixture of the old school and the new college.

Most of the changes in the curriculum were put through after the first year as a college, starting from the academic year 1919-1920. During the 1920s and 1930s

[48] *Archive Lh*, 10 and 441. Valckenier Suringar, "Eene belangrijke kwestie." Van der Haar, *Geschiedenis I*, 232.

[49] *Archive Lh*, 534. Van der Haar, *Geschiedenis I*, 213-214.

several other changes in the curriculum were effectuated. The changes are characterised by two elements, a reduction in the number of compulsory courses and the creation of different specialisation options within the programmes. In the early 1920s the college management introduced different course tracks in the programmes for Dutch Agriculture and Colonial Agriculture. Both programmes had tracks in crop cultivation, cattle breeding and economy and Dutch agriculture had an extra track in processing of dairy products. These tracks were all based on a collective propaedeutic year and started for Dutch agriculture in the third and for Colonial Agriculture in the second year. Table 4, where the Colonial Agriculture tracks in tropical crops, cattle breeding and economy are numbered I, II and III respectively, shows that there was quite some overlap between the course tracks. The real specialisation came in the final years when a thesis subject was chosen. The orientation in the different course tracks was partly based on different sectors in agriculture (crops, cattle breeding), partly on a disciplinary fields (technical, economic). It was this orientation of study tracks that became an issue in the discussion about the curriculum in the 1920s and 1930s.

**Table 3: Courses in the 2nd year of the Agricultural College 1919-1920. (Source: *Programma van het onderwijs*)**

| **Dutch Agriculture** | **Teacher** | **Hours per week** | | **Colonial Agriculture** | **Teacher** | **Hours per week** | |
|---|---|---|---|---|---|---|---|
| *Compulsory* | | Lec | Lab | *Compulsory* | | Lec | Lab |
| Crop science | H. Mayer Gmelin | 2 | | Tropical crops | dr. A. van Bijlert | 2 | |
| Genetics | dr. .J.A. Honing | 2 | | Irrigation | J.H. Thal | 1 | |
| Plant anatomy | dr. E. Giltay | - | 3 | | Larsen | 2 | |
| Agric. chemistry | J.H. Aberson | 2 | 2 | Genetics | dr. .J.A. Honing | - | 3 |
| Cattle breeding | L. Broekema | 2 | | Plant anatomy | dr. E. Giltay | 2 | 2 |
| Zoology | H.C. Reimers | 2 | | Agric. chemistry | J.H. Aberson | 2 | |
| Dairy farming | B. van der Burg | 1 | | Col. Economics | dr. J.C. Kielstra | | |
| Agric. economics | S. Koenen | 2 | | | | | |
| | | | | *Optional* | | | |
| *Optional* | | | | Land surveying | J.W. Dieperink | 2 | 2 |
| Soil-water | | | | Agr.geology | J. van Baren | 1 | |
| engineering | J. Elema | 1 | | Zoology | L. Broekema | 1 | |
| Phytopathology | dr. H.M. Quanjer | | | Probability | dr M.J. van | 2 | |
| Agr. geology | J. van Baren | 1 | 2 | calculation | Uven | | |
| Probability | dr M.J. van Uven | 1 | | Agrarian. Law | dr. J.C. Kielstra | 1 | |
| calculation | | 2 | | Plant physiology | dr. A.H. Blaauw | 1 | |
| Agr. law | dr. A.H. Heringa | 1 | | | | | |
| Plant physiology | dr. A.H. Blaauw | 1 | | | | | |
| Electricity & agric. | dr. D. van Gulik | 1 | | | | | |

One of the first public criticisms of the study programme came from A.H. Blaauw (1882-1942). Blaauw was professor in plant physiology at the Agricultural College. He was educated at the University of Utrecht where he received a doctorate in 1909, supervised by F.A.F.C Went. In Wageningen he continued research on the topic of his thesis, light response of plants, mainly applied to horticultural crops.[50] In 1922 Blaauw published a brochure in which he formulated several organisational changes for the Wageningen institution. Regarding education, he argued that the programmes should be split up in two elements, following the law, stating that higher agricultural education consisted of formation and preparation for independent profession of agricultural science, and for societal positions for which scientific education is required. In other words, education for employment in universities and research institutes on the one hand and for academic jobs in society in general on the other. In the eyes of Blaauw it would be more efficient to split these two types of education up in two study programmes. "And when in short we call these two programmes 'practice' and 'research', we deliberately avoid to add the term 'scientific' to one of these, because if students choose one of these two programmes, the demand for all of them is that they receive education in which they learn to think scientifically and critically, learn with logic to investigate or to organise or to manage."[51] According to Blaauw this division had a legal basis, reflected the needs of society and was also rooted in the mind of a student.[52] Some students were psychologically more suited for research, others were more practically talented. Blaauw's proposals were mainly programmatic, and although he did not reject a more vocational orientation, his main objective was to create a special course track for the education of researchers.

[50] Arisz, "Levensbericht van Anton Hendrik Blaauw", 227-249. Faasse, *Experiments in Growth.*

[51] Blaauw, Over *organisatorische verbetering*, 22.

[52] Ibid.

**Table 4: Courses in the 2nd year of the Agricultural College 1930-1931. (Source: *Programma van het onderwijs*)**

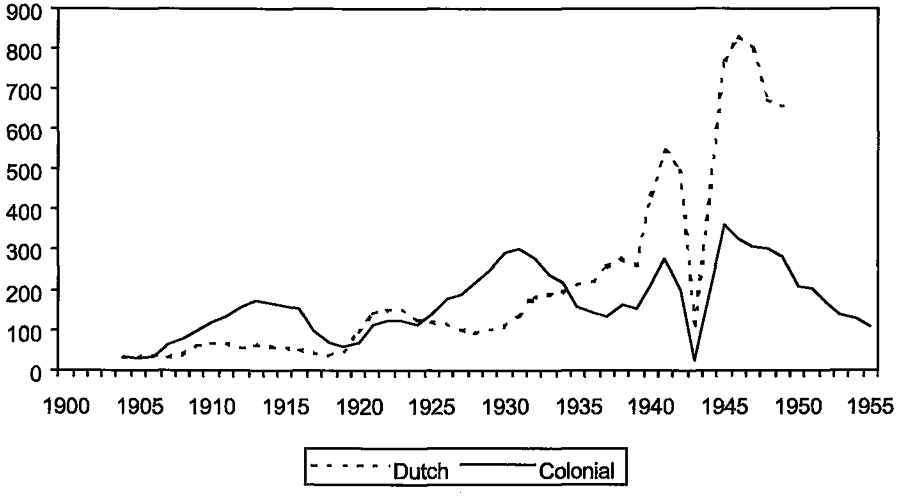
| Dutch Agriculture | Teacher | Hours per week | | Colonial Agriculture | Teacher | Hours/ week | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Le | Lb | | | I | II | III | Lb |
| *Compulsory* | | | | *Compulsory* | | | | | |
| Crop science | H. Mayer Gmelin | 2 | | Tropical crops | J.E. v.d. Stok | 1 | 1 | 1 | |
| Genetics | dr. .J.A. Honing | 2 | | Irrigation | J.H. Thal Larsen | 2 | | 2 | |
| Plant physiology & | dr. E. Reinders | 1 | 3 | Genetics | dr. .J.A. Honing | 2 | 2 | 2 | |
| anatomy | | | | Plant physiology | dr. E. Reinders | 1 | 1 | 1 | 2 |
| Agric. chemistry | J. Hudig | 2 | 2 | & anatomy | | | | | |
| Cattle breeding | dr. D.L. Bakker | 2 | | Agric. chemistry | J. Hudig | 2 | 2 | 2 | 2 |
| Zoology | dr. G. Grijns | 2 | | Col. Economics | dr. J.C. Kielstra | 2 | 2 | 2 | |
| Dairy farming | B. van der Burg | 1 | | Agr. law | dr. J.C. Kielstra | | | 1 | |
| Agric. economics | dr. G. Minder- | 2 | | Cattle breeding | dr. D.L. Bakker | | 2 | | |
| | houd | | | Zoology | dr. G. Grijns | | 2 | | |
| *Optional* | | | | *Optional* | | | | | |
| Soil-water | J. Elema | | | Land surveying | | | | | |
| engineering | | | | Agr.geology | W. Dieperink | | | | |
| Agr. geology | J. van Baren | | | Prob. Calculation | J. van Baren | | | | |
| Probability | dr M.J. van Uven | | | Colonial law | dr M.J. van Uven | | | | |
| calculation | | | | Entomology | dr. J.C. Kielstra | | | | |
| Agr. law | dr. A.H. Heringa | | | Electr. & agric. | dr. W. Roepke | | | | |
| Electricity & agric. | dr. D. van Gulik | | | Plant taxonomy & | dr. D. van Gulik | | | | |
| Medical training | dr. K.A. Hoekstra | | | -geography | dr. J. Jeswiet | | | | |
| | | | | Medical training | dr. K.A. Hoekstra | | | | |

As discussed in chapter three, Blaauw also argued for a clearer distinction between the research performed by the professors or "freely chosen examinations that might be of interest for agricultural science" as he called it, and the research work performed at the regional experiment stations. But similar to his view on the organisation of agricultural research, Blaauw's idea of higher agricultural education was not unchallenged either.

## Feedback from practice

Several Wageningen graduates responded to Blaauw's brochure in the *Landbouwkundig Tijdschrift*, a journal issued by the association of agricultural engineers, raised in 1886 on the initiative of J. Sibinga Mulder. One of the graduates who replied to Blaauw questioned how graduates from the 'research' programme could be distinguished from university graduates and feared that graduates from the 'practice' programme were no different from graduates from the agricultural schools in Groningen and Deventer.[53] Another respondent argued that not research but practice was underrated in the curriculum and pleaded for a course 'synthetic agricultural science'. "Like the medical student after several courses has to study the human body as a whole, so must the agricultural student learn to study a farm unit. In that course he must be shown how all elements hang together like one organism and that a farm can be healthy or ill. He must be able to find the deficiencies and what aid is required. If the chemist must be called in, the veterinary or the mechanical engineer."[54] The *Landbouwkundig Tijdschrift* had a crucial function in all kind of debates and developments in the agricultural sciences. Moreover, the graduate association frequently held surveys among its members about various issues and often launched commissions to examine certain developments in agricultural science.

**Figure 2: Student numbers of Dutch programmes (Agriculture, Forestry and Horticulture) and Colonial Programmes (Agriculture and Forestry), 1904-1955. (Source: Programma van onderwijs.)**




In 1931, the association announced a commission to investigate how the Wageningen education in the programme Colonial Agriculture could be improved in order to fit the requirements for scientific employment in the Dutch East Indies. The commission, consisting of representatives of experiment stations, agribusiness and extension service, traced the position of 489 Wageningen graduates, interviewed several graduates in leading positions and recent graduates in the Dutch East Indies. After analysis of the figures the commission

[53] *Landbouwkundig Tijdschrift* (1923), 79-81

[54] Ibid., 119-120.

concluded that the majority of the graduates from the Colonial Agriculture programme were employed as extension workers in either sugarcane cultivation or indigenous agriculture. The commission considered both types of work environments as 'agricultural practice' and "[t]he Wageningen programme has to take that into account by putting emphasis on general agricultural-scientific formation, while a strongly specialised study should be possible, but cannot be forced on all."[55] The advise was supported by the interviews of graduates in leading positions who noted a lack of understanding of agriculture among employed Wageningen graduates, especially those specialised in economy. Similar complaints were given by the recently graduated, who put the blame on the many professors in Wageningen lacking an agricultural background. Based on these findings the commission made a detailed proposal to improve the study programme of Colonial Agriculture. Besides adjusting existing courses the commission proposed to add in the first year a course in 'general agronomy' with field excursions to farms in the neighbourhood of Wageningen. The period of practical training, (*praktijktijd*), a compulsory element for which students were sent off for six months mostly to a farm in the Netherlands, should have more attention as a learning experience. The commission further remarked that specialisation in a discipline where students were trained as researchers should be possible, but primarily in a post-graduate phase leading to the degree of doctor.[56]

**Table 5: Graduates employed in the colonies in 1932. (Source: Nederlandsch-Indisch Instituut, "Rapport betreffende de studie.")**

| | |
|---|---|
| Sugar cane plantations | 118 |
| Other plantations | 70 |
| Private experiment stations | 28 |
| Public experiment stations | 28 |
| Public agricultural services | 72 |
| Forestry service | 135 |
| Other jobs in agriculture | 14 |
| Other jobs outside agriculture | 24 |

The report of the commission can be compared with recently collected interview material.[57] All interviewees graduated before 1940 worked for several years in the Dutch East Indies. Most of them stated that they lacked insight in the practical elements of cultivating crops, especially in relation to graduates from the colonial

[55] Nederlands-Indisch Instituut, "Rapport betreffende de studie aan de landbouwhoogeschool", 468.

[56] Ibid., 469-475.

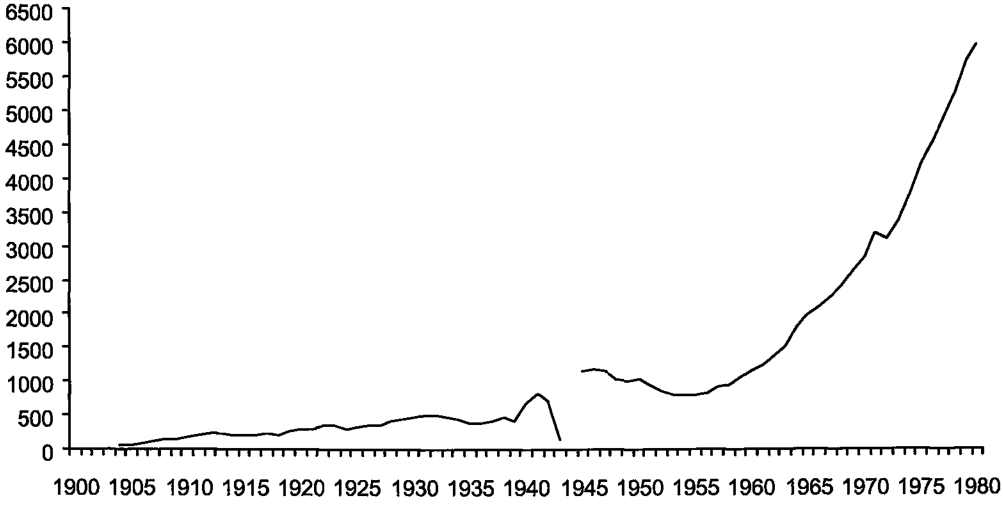
[57] Based on interviews with twelve Wageningen alumni, graduated before 1940.

agricultural school in Deventer. "In plantation agriculture all administrators were guys from Deventer. They knew how to handle crops." All respondents said that they learned the ins and outs of agricultural practice through the years. Several interviewees, however, also stated that compared to colleagues trained as biologists at one of the Dutch universities they knew much more about agriculture and different disciplines. None of the interviewees said they experienced serious knowledge gaps after graduation. Most enjoyed their time in Wageningen. Besides the question about the knowledge of practical agriculture, interviewees were also asked if they considered the curriculum a coherent and balanced study programme. The overall response to this question was negative. Especially the first year was considered a loose list of courses with no or very little relevance. "There was a course in hydraulics where we had to learn by heart 40 complex formula that you forgot a day after the examination. I never used it anyway." But also the rest of the programme was not considered very balanced. "Coherence was only visible in the word 'tropical' and even that was lacking in some courses." "I always wondered why professors, who all knew each other very well, never referred in their lectures to courses from other professors." All interviewees stated that throughout their study they built up a coherent set of courses themselves.

**Unresolved tensions**

In the first half of the twentieth century agricultural education in Wageningen moved from the system of middle education to the system of higher education. A major effect of this transformation was an increasing pressure on the school to perform as a university, mainly translated in educating qualified researchers for the experiment stations and other research institutes in the Netherlands and its colonies. But neither the proposal from Blaauw to split up the curriculum in programmes for research and practice, nor the proposal to strengthen knowledge of farming was really implemented until the 1950s. A major reason for that must be sought in the functioning of the board of professors, the senate. The senate of the Agricultural College was a rather stable and solid force in the management of the college. A very clear example is the attempt of the government to install faculties at the Agricultural College.

**Figure 3: Student numbers of the Wageningen institution over 1904-1980.**
**(Source: *Programma van onderwijs*. *Jaarverslag Lh.*)**




The idea to create faculties or similar units in the Wageningen institution was already raised in the 1910s. Kamerling mentioned it in his criticism on the education and the issue was also discussed in parliament in 1917 with debate about the inclusion of the Wageningen institution in the system of higher education. Being asked how he foresaw the division, the minister answered that he wanted to wait some years to see how agricultural science developed, before a decision was made.[58] The issue was not arranged in the law but after two years the board of trustees urged the senate to make a proposal for a division in faculties. In September 1921 a commission of six professors worked on the issue, but could not agree. Three options were discussed. One was a division in more research-oriented chairs and teaching chairs. The option was rejected because "many colleagues do not have a natural allocation in the scheme."[59] Another option presented was a division in fundamental sciences and applied sciences, but was also rejected because it did not consider the importance of education. Nor was a division based on the study programmes any more acceptable. The conclusion of the commission, therefore, was that "no definite division in faculties or departments can meet the intended purpose to relieve the Senate of some of its tasks and therewith to accelerate decision making."[60] In 1931 the board of trustees made a second attempt. Again, a senate commission was installed, and again

[58] Van der Haar, *Geschiedenis I*, 158.

[59] *Archive Lh*, 2027.

[60] Ibid.

they resisted. "Contrary to the Board of Trustees we feel that only the current procedure, to get advise from *ad-hoc* commissions solely consisting of experts, is better than when the Senate would be split up in divisions according to this or that scheme. Serious objections against the current procedure have never come to our ears."[61] The exercise was repeated once more in 1933 with the same negative result.

The failed attempts to create faculties in the Agricultural College show several things. First of all, the Senate was a rather coherent group. Between 1918 and the second World War the number of professor remained stable at about thirty. Moreover, there was some sense of solidarity, effective in resisting outside pressure to reorganise the decision-making process in the Agricultural College. The activities of the senate commission studying the option of faculties also shows that the professors considered the varying and hybrid character of the Agricultural College as difficult to classify or separate. As the various criticisms on education make clear, that does not mean that everyone considered the diversity in focus and subjects as positive. The options for a possible separation in faculties, discussed by the senate commission, make very clear what the tensions were in the Agricultural College. The relation between research and teaching activities, fundamental and applied science, and the division of courses over the study programmes were the main differences in views and activities of the professors. Although the study programme was adjusted several times, the overall structure was maintained. The size and position of the senate in the 1920s and 1930s favoured a continuation of the status quo. This period of relative quiet was broken abruptly by the second World War. The town of Wageningen, located on the border of the Rhine, was caught in the frontline, both at the beginning and then at the end of the war. Many college buildings were ruined. Moreover, three professors openly expressed Nazi sympathies and were expelled from the university after the war.[62] In the second half of the 1940s the board and professors took up activities again, including discussion about the study programme.

## Disciplinary differentiation

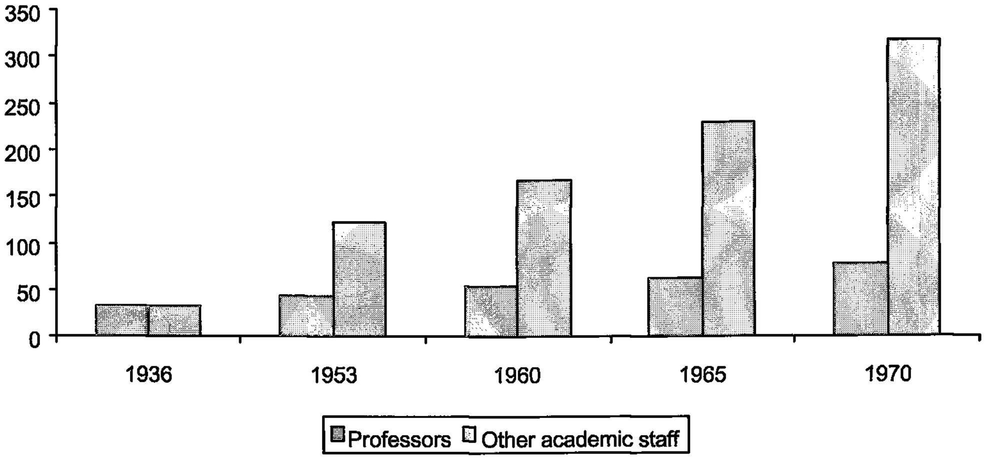
Looking at some figures of the Agricultural College (*Landbouwhogeschool*) over a period of two decades before the second World War and a same period after 1945 gives the strong impression that the war was a breaking point in the history of the Wageningen institution. The group of professors had a stable number of about thirty until the 1940s, but in 1965 its size had doubled. Student numbers also

[61] Ibid.

[62] Van der Haar, *Geschiedenis I*, 277-332

curve upwards in the post-war period. Large investments, available through the Marshall aid programme, were made in agricultural research and education to stimulate agricultural productivity and undo the food shortages of the post-war years, investments that also reached the research and education facilities in agriculture. In short, there was a clear quantitative growth from 1945 onwards.

**Figure 4: Number of professors and other academic staff *Agricultural College Wageningen* over 1936-1970. (Source: Van der Haar, Geschiedenis I, 329.)**




The resumption of research and teaching activities at the Agricultural College initiated some fundamental changes in the management of the institution. In 1949 a number of professors wrote a letter to the rector complaining about the sluggish administrative machinery, especially the slow availability of funds for restoration of laboratories and equipment. The letter resulted in the installation of a senate commission to look at a revision of the management structure. The commission proposed to integrate the daily management of the college with the board of trustees and create a new board, consisting of the rector, two other professors and five external managers. The daily management was put in the hands of the rector, one external manager and the university secretary, head of the administrative bureau. The plan was effected in 1956.[63] A major effect of the reorganisation of the management was a reduction in professors' influence. Although the senate was not abolished, its function became more that of an advisory board. The role of the professors in the university management was further reduced at the end of the 1960s when a council consisting of representatives of academic staff, non-academic staff and students, replaced the senate. The gradual loss of power of

[63] Van der Haar, *Geschiedenis II*, 135-149.

the professors regarding the management of the institution does not imply, however, that professors became isolated individuals. Figure 3 makes clear that the growth in the number of professors was very small compared to the growth of academic staff. These staff members, employed for research and teaching, functioned in a group structure - called institute, laboratory or department - headed by a professor. Although the situation was certainly not new, professors had to function more and more as team leaders. As a result, group formation in the Wageningen institution was less based on affinity among professors and more on affinity between staff members headed by a professor. In other words, the departments became the central units of the Agricultural College.

The changes in the organisation and management structure of the Agricultural College, together with the growth in staff and students, cleared the way for a change in the education structure. New study programmes and more students implied a division of teaching subjects and capacity over a wider range of programmes. Each department tried to get a serious part of the teaching, and tried to emphasise its own disciplinary issues in the education programme. This process was stimulated by reports and advice from several commissions. But similar to the situation in the 1920s and 1930s, the differentiation of the study programme after the 1940s was challenged by a call for more integration.

**General agricultural studies**

The first rector of the Agricultural University in Wageningen after the second World War, C.H. Edelman (1903-1964), a geologist trained at the Technical College in Delft, reopened the debate about the orientation of the study programme in November 1945. In a public lecture he stated that the majority of students did not pursue science but aspired to an appropriate position in society. For the Agricultural College that implied that "students come to Wageningen to study agriculture. Who is not interested in agricultural questions does not belong in Wageningen."[64] Edelman argued that a special course in general agricultural studies (*algemene landbouwkunde*) should be added to the first year programme. A year later Edelman chaired a group of Wageningen graduates to work out a plan for a new study programme. Again the main message was the creation of a first-year course in general agricultural studies, including an overview of the main agricultural crops in the world, different types of farms in the Netherlands, field excursions and a short internship on a farm. A follow-up course in the second year of the programme Dutch Agriculture should be compulsory as well. The new courses should be lectured by a newly appointed professor.[65]

[64] Edelman, *De vernieuwing van de Landbouwhogeschool*, 9.

[65] Van den Ban, *Toelichting bij een ontwerp*.

Late 1940s a commission installed by the Wageningen graduate association further considered the idea of Edelman. The commission, consisting of six professors, invited a number of representatives from institutes and companies in the agricultural sector to hear their opinion on several issues. One of the questions concerned the introduction of a course on general agricultural studies to which none of the interviewees had serious objections.[66] The involvement of Wageningen professors meant that most issues that were raised by the graduate association reappeared on the agenda of senate commissions and in the official reports produced in those days. The proposal for a course in general agricultural studies already had effect in 1949 when experimental lectures were included in the first year programme. With the major reorganisation of the education in 1956 the course became a compulsory element of the propaedeutic year and an optional course for several second year programmes. In 1957 J.G. Veldink was appointed to teach the issue, which he did until 1979.[67] Veldink was not appointed as a professor but as a lector, a position with less status and salary than a professorship.

Once included in the programme, the issue disappeared from the agenda. What can be questioned is if a first year compulsory course and extra course options in later years filled the need for an integrated perspective on agricultural problems as expressed in the various contributions. The solution to add a course to the curriculum and appoint someone to teach the issue, however, is a typical phenomenon of the period 1950-1980. The added courses were mostly optional and as Table 6 shows, the number of courses students could select from besides the compulsory elements was considerable.

[66] Reinders, *De reorganisatie van het onderwijsprogramma.*

[67] Van der Haar, *Geschiedenis II*, 20.

**Table 6: Programme Tropical Agricultural Production 1980-1981. (Source: *Programma van het onderwijs*)**

| **Compulsory courses** | | **Optional courses** |
|---|---|---|
| *Second year:* | *Fourth year:* | A total of 92 courses is listed. Courses |
| Mathematical statistics | Applied statistics | can be taken from the second year. |
| Plant physiology | Development economics | Advised combinations ('profiles') are |
| Genetics | Pastures | headed as: |
| Principles of plant | Tropical crops | |
| production | Tropical soils | Tropical crops – general |
| *Third year:* | Soil fertility | Soil & water |
| Organic chemistry | Soil tillage | Crop protection |
| Meteorology & climatology | Tropical medicine | Processing of crops |
| Botany | | Project planning & implementation |
| Taxonomy & plant | | Crop research |
| geography | | |
| Tropical crops | | |
| Geology and soil science | | |
| Soil fertility | | |

The role of the graduate association in the creation of a lector's post in general agricultural studies implied a new emphasis of the association. Since its origin the association monitored the career paths of the graduates and signalled new requirements and positions on the job market. With the growth of the students numbers, keeping track of numbers of graduates and other monitoring work became more and more dependent on surveys and statistical processing of data. An example of this survey work will be discussed further down. The effect of the professionalization of the graduate association, in combination with the growing amount and variety of graduates was that the role of the association's journal, *Landbouwkundig Tijdschrift*, in the discussion about the education diminished. From the late 1960s this role was taken over by student associations. As will become clear further down, the student associations picked up similar issues in the 1970s and 1980s as the graduate association did from the 1920s until the 1940s. In the two decades between those periods the education of the Agricultural College was steered in another direction.

## Educating fundamental researchers

In the late 1940s the Dutch government established an organisation for pure scientific research, *Zuiver Wetenschappelijk Onderzoek*, ZWO. The ZWO organisation can be considered as the counterpart to the organisation for applied natural-scientific research (the TNO, discussed in chapter three). The main objective of the ZWO organisation was to enhance pure scientific research by grants for short-term research contracts in several disciplines of the natural sciences.[68] As discussed in chapter three, the developments in agricultural research in the late 1940s and 1950s included a tendency to distinguish between applied and fundamental agricultural research. The government initiative in stimulating pure scientific research with the creation of the ZWO stimulated the senate of the Agricultural College in Wageningen to ask the minister to assign a commission to set out a policy for the stimulation of fundamental research in agriculture. The commission was chaired by V.J. Koningsberger (1895-1966), professor in botany at the University of Utrecht. Further external members were an economics professor from Rotterdam and a professor in biochemistry from Leiden University. The Wageningen professorial members were E.W. Hofstee and S.J. Wellensiek. One of the questions the commission addressed was how the education in Wageningen might meet rising demand for researchers, both in quantity and quality.[69]

The main diagnosis of the commission was that the Wageningen study programme lacked the possibility to specialise in a field of fundamental research in an early stage. The formulation included two elements. One of the problems was a limitation in optional courses. Although the programme had a wide variety of study tracks most courses in the tracks were compulsory. "The commission thinks that in principle the Agricultural College can create better career opportunities by reducing the number of study tracks and to increase the internal course options."[70] The other problematic element was timing. The commission admitted that many Wageningen graduates were very good researchers but students could only specialise in the final study phase. The second and third year programme did not support and stimulate students to specialise. "Mainly he is occupied by studying many, often widely varying courses, where obtaining factual knowledge and a rough understanding prevails over going into the causal patterns that influence the phenomena of the study objects."[71] Besides allowing students to specialise through optional courses in an early phase of the programme, the commission also proposed to create better opportunities for a PhD phase. Employment regulations were considered the main obstacle accounting for the small number of doctoral theses produced in Wageningen. In the current situation PhD candidates were employed as research assistants, often implying that they were busy with other tasks. Moreover, the legal status of research assistant was a permanent position. This made professors cautious in appointing a candidate and candidates reluctant to finish the thesis. The commission therefore proposed to offer PhD candidates finite contracts with thesis writing as the only task.

[68] Kersten, *Een organisatie van en voor onderzoekers.*

[69] Van der Haar, *Geschiedenis II*, 26-36.

[70] Koningsberger, *Rapport der Commissie fundamenteel onderzoek in de landbouw*, 22.

[71] Ibid., 23.

On several pages of the report the commission stressed that fundamental research should not result in neglecting the agricultural character of the Wageningen institution. Nevertheless, the main message of the commission was that the Wageningen institution should behave more like a university. "The education at a university takes place - with the exception of medicine and veterinary medicine - almost entirely in the sphere of fundamental science and research."[72] True or not, the perception of proper university education expressed by the commission found a willing ear among the majority of the Wageningen staff and the adjustments of the study programme in the 1960s and 1970s very much resembled the recommendations of the commission. The increase in specialisation options was to be achieved primarily by creating various study tracks within programmes. Students could decide to follow such tracks from the second year. In 1980 the propaedeutic year was also split up, covering clusters of similar programmes. Reading through the various sources of the 1960s and early 1970s gives the impression that the report Fundamental Research in Agriculture expressed and supported a wider sustained perception of agricultural science and higher agricultural education in those days.[73] But the report of the commission chaired by Koningsberger was not the only steering force in the creation and innovation of education programmes. To get an idea what other elements played a role, the changes in the programme for Colonial Agriculture will be examined in the following paragraphs.

**A new perspective for colonial agriculture**

The nationalistic movement in the Dutch East Indies, openly pursuing independence from the Dutch colonisers since the 1920s, used the Japanese occupation to enhance its goals, resulting in the declaration of the Republic of Indonesia in 1946. Between 1946 and 1949 the Dutch tried to restore their power but they fought without international support and against a determined Javanese population, a lost cause. When the Dutch admitted defeat the former colonial government services were taken over by the republican government and all Dutch officials were expelled. Private agricultural enterprises were allowed to continue their work until 1956, when most enterprises were nationalised and Dutch employees and owners left the country as well. Consequently, the independence of Indonesia implied a loss of employment opportunities for a large number of agricultural experts. The remaining overseas territories (New Guinea till 1962, Surinam till 1975 and the Antilles until present day) could not compensate, as their total agrarian sector was insignificant compared to that of the former Dutch East Indies.

[72] Ibid., 5.

[73] Van der Haar, *Geschiedenis II*, 259-274.

The Dutch East Indies were always considered as very important for the student inflow of the Agricultural College. In 1925 for example the head of the colonial Department of Agriculture, when on leave in the Netherlands, launched the idea to open an agricultural faculty on Java. The secretary of the board of trustees reacted in a letter to the minister stating that the ideas "are a danger, that in my mind threatens the future of the *Landbouwhogeschool*."[74] The threat was specified in terms of the number of graduates for the Dutch agrarian sector that, according to the secretary's calculations would not exceed sixty a year, not enough to maintain a body of thirty professors. The new agricultural faculty in Buitenzorg, however, was supposed to educate agriculturists at a lower level than the Wageningen graduates, and the plans were established in the 1940s. Shortly after the war the position of Wageningen graduates was at stake again. This time it was an inflow of foreign agronomists applying for the positions left vacant by war victims and repatriated Dutch agronomists. This foreign inflow was considered a threat to the Dutch cause in Indonesia.[75] Both examples can be considered as premature reactions to unclear developments, but the apparent uncertainty reveals the perception that there was a vital connection between Wageningen and the colonies. The remark about the threat posed by foreign experts in Indonesia came from a letter to the senate of the Agricultural College, written by E. de Vries.

Egbert de Vries (1901-1993) was a Wageningen graduate who started his career in the colonial extension service. His interest in the indigenous farm economy lead him first to a doctorate, received in Wageningen in 1931, after which he climbed up to the position of head of the Economics Department of the colonial government. He chaired a commission that designed the agricultural faculty in Bogor in the 1940s, and returned home in 1946 to become professor in Agricultural Economy of the Overseas Territories at the Agricultural College in 1947. From the moment of his repatriation he was advisor to the minister of Foreign Affairs and combined his professorship with a directorship of the economics division of the foreign ministry.

De Vries played a crucial role in the formulation of a Dutch programme for international development aid, in those days called 'technical assistance'.[76] The national programme was developed in relation to international organisations like the United Nations (UN), its Food and Agricultural Organisation (FAO), the World Bank and the International Monetary Fund (IMF). Another important player in this was the United States of America, a country which had in the words of its president in 1949 launched a 'bold new program' to speed up the economic development of backward nations. The Netherlands, in the words of de Vries, should be a crucial player in the new international development cooperation. "In

[74] *Archive Lh*, 1160.

[75] Van der Haar, *Geschiedenis II*, 14-15.

[76] Van Soest, *Het begin van de ontwikkelingshulp*, 223-243.

the tropical regions there is a complex of economical, social and political issues caused by under- and overpopulation, that creates an enormous field of activity for tropical agriculture. We Dutch have to contribute in this field, on penalty of falling back to the level of a very small nation. We can join because in this field we have a wealth of knowledge and experience. Wageningen has a very good name internationally in the field of tropical agriculture."[77] The colonial background together with diplomatic activities made the words of de Vries come true. In the early 1950s the Netherlands maintained a fourth position in number of experts posted abroad, after the USA, the UK and France.[78] These experts were not all Wageningen graduates and de Vries' activities concerned colonial education programmes of other universities too.[79] The main merit of de Vries for these education programmes was that he played a crucial role in convincing the Dutch government there should be a broadening of the tropical orientation of Dutch universities, instead of a discontinuation of the tropical education programmes.[80] The activities of de Vries make clear that a focus on all sorts of national and international developments were an important source of information for the Agricultural College to develop and renew its education. The wider orientation on social and economic developments was to combine very well with an orientation on research, as the activities of another professor in the field of tropical agriculture show.

Where Egbert De Vries promoted higher education in tropical issues on a national and international policy level, C. Coolhaas (1895-1966) was a more hidden diplomat. Caspar Coolhaas graduated in Wageningen in 1921 and stayed in Wageningen, working at the laboratory of microbiology, and defending a doctorate thesis in 1927. From 1928 to 1943 he worked at the tobacco research station in Klaten on Java, from 1938 as director of the station. After the war he briefly supervised the organisation of the associated research stations for perennial crops on Java and Sumatra. In 1948 he returned to Wageningen and succeeded J.E. van der Stok as professor in tropical crops.[81] Like De Vries, Coolhaas realised that Dutch agriculturists should broaden their perspective. "Of course the Dutch agricultural or forestry expert would prefer employment in Indonesia, that's so near to him, over employment somewhere else in the tropics where the situation, climate and living conditions are often worse than in Indonesia. That is why in former days hardly anyone went to other places. This, however, might change, and we have to give due consideration to that."[82]

[77] De Vries, "Ontwikkeling van de tropische landbouw", 422.

[78] Van Soest, *Het begin van de ontwikkelingshulp*, 324-334.

[79] Kloos, "Het ontstaan van een discipline", 123-146.

[80] Ibid., 130.

[81] "In memoriam", 71.

[82] Coolhaas, "Openingsrede", 420.

Coolhaas himself developed this consideration in a number of travels to many tropical countries, promoting the Dutch experience in tropical crops.

In July and August of 1950 he travelled to Brazil, Surinam and Trinidad. In Brazil the directors of the research stations Coolhaas talked to were primarily interested in experienced researchers from the Indonesian research stations. Surinam still was a Dutch colony so little lobbying was needed there and representatives of the colonial institutes at Trinidad showed primarily an interest in experienced planters.[83] Besides South America and the Caribbean Coolhaas travelled to Africa as well. In 1949 Coolhaas visited an oil palm conference in Nigeria where one of the English research directors told him they were interested in specialists for soil chemistry, plant physiology, phytopathology and plant breeding. "As also turned out in the cocoa conference in London, the British research stations in Africa struggle with a shortage of staff. This will be specifically urgent because they plan to expand the research activities. (...) Our impression is that in this area the Dutch have a good name, their tropical experience is a valued item, that should not be priced too low."[84] In 1952 Coolhaas travelled with some French authorities through West Africa leading to the establishment of a Dutch research station at Adiopodoumé in Ivory Coast. The station primarily functioned as a post where students and researchers from Wageningen could work in African conditions. A similar post was opened in Surinam in 1965.[85] The network developed by Coolhaas not only functioned through contacts with foreign officials but also through Dutch diplomats and Wageningen graduates working in tropical countries. Besides creating employment opportunities for his students the contacts and outposts also allowed staff members to acquire knowledge and experience of tropical agriculture in other areas than Indonesia.

The activities of Wageningen professors de Vries and Coolhaas show that much effort was put into giving the former education programme in colonial agriculture a new perspective. Several Wageningen graduates interviewed from that period stated that the contacts of Coolhaas were very helpful in finding their first job. The consequence of the new orientation on international development cooperation, and the networking with international organisations and tropical research institutes, was that courses in the tropical programmes gradually lost an explicit and exclusive focus on Indonesia. Some new course tracks within the former programme colonial agriculture are an understandable implication as well. But in the 1950s and 1960s entirely new education programmes with a focus on tropical agriculture were set up.

[83] *Archive Lh*, 2153.

[84] Ibid.

[85] Van der Haar, *Geschiedenis II*, 16-19.

**Academic expansion**

The programme structure in colonial agriculture was formally abolished in 1956. The original course tracks in tropical crops and economy became separate study programmes. The course track in tropical cattle breeding was included in the programme 'zootechnical studies'. Moreover, two new programmes were added: one in non-western sociology, the other in tropical land development (*tropische cultuurtechniek*) covering irrigation and drainage. Non-western sociology was the new name of an education programme that was offered in Wageningen and the universities of Leiden and Utrecht. It replaced the former programmes that primarily aimed at the training of colonial civil-servants. In 1955 R.A.J. van Lier was appointed in Wageningen as professor in this subject. Van Lier, born in Surinam, defended his doctoral thesis in Leiden in 1949, where he received a professorship in the same year. Together with E. de Vries he was one of the pioneers in broadening the perspective of the former colonial programmes.[86] The new programme in tropical land development was led by professor W.F. Eijsvoogel, graduate of the Technical College in Delft. Eijsvoogel was appointed in Wageningen in 1946 to teach hydrological and engineering issues to students following the programme in tropical agriculture. The creation of these two programmes is somewhat remarkable as there were no former study tracks in the same issues in the former programme colonial agriculture. Issues in water management in the Dutch East Indies were primarily handled by graduates from the Technical College of Delft and sociological issues of the colonies (together with colonial law) were lectured at the universities of Leiden and Utrecht.

The establishment of separate programmes in tropical land development and non-western sociology is difficult to explain from the change in perspective from colonial agriculture to international tropical-agrarian issues. Although the issues were present as course elements in the former programme on colonial agriculture, there are hardly indications that in the 1950s the demand for specialists in tropical water management or non-western sociology suddenly increased. What did increase was the student intake, although in the 1950s the curve of student numbers had not yet made the steep upward bend. What was considered necessary in those days was a differentiation of programmes in order to educate more specialised agriculturists. Professors of the Wageningen College needed few arguments to create a specialisation option in their discipline. The background and origin of the programmes in land development and non-western sociology make clear that professors and management of the Agricultural College kept an eye on other institutions in the formulation of new education programmes. In other words, the implicit message of the commission chaired by Koningsberger, 'behave like university', was also interpreted as copying the activities of other academic

[86] Kloos, "Het ontstaan van een discipline", 131. Van der Haar, *Geschiedenis II*, 112-114.

institutions. Another clear example of that is the introduction of a study programme in biology in the academic year 1971-1972.[87]

[87] Van der Haar, *Geschiedenis II*, 261-270.

**Table 7: Differentiation of the study programme at the Wageningen institution at 5 sample periods. (Source: *Programma van het onderwijs.*)**

| 1876 | 1905 | 1935 | 1960 | 1975 |
|---|---|---|---|---|
| Agriculture<br><br>Optional extra courses in various topics | Dutch agriculture<br><br>Colonial agriculture<br><br>Dutch forestry<br><br>Colonial forestry<br><br>Horticulture<br><br>Optional extra courses in various topics | Dutch agriculture - 4 specialisation options<br><br>Colonial agriculture - 3 specialisation options<br><br>Dutch forestry<br><br>Colonial forestry<br><br>Horticulture<br><br>Optional extra courses in various topics | Arable crops and pastures<br>Tropical crop production<br>Horticultural crop production<br>Plant breeding<br>Phytopathology<br>Cattle breeding<br>Tropical cattle breeding<br>Dairy processing<br>Forestry (growth)<br>Forestry (processing and economics)<br>Garden and Landscape architecture<br>Economics<br>Tropical economics<br>Agrarian sociology<br>Agrarian sociology of non-western regions<br>Agricultural household studies (technical)<br>Agr. household studies (social-economical)<br>Land improvement<br>Tropical land improvement<br>Agr. mechanics<br>Agr. technology<br>*Specialisation options for each programme* | Agricultural crop production<br>Tropical crop production<br>Horticultural crop production<br>Plant breeding<br>Phytopathology<br>Forestry<br>Cattle Breeding<br>Land improvement<br>Tropical land improvement<br>Agr. mechanics<br>Soil and fertilisation studies<br>Process engineering<br>Human nutrition<br>Environment studies<br>Molecular sciences<br>Biology<br>Economics<br>Landscape architecture<br>Land planning<br>Sociology of western regions<br>Sociology of non-western regions<br>Household studies<br>*Specialisation options for each programme* |

Following the descriptions of the programmes related to tropical agriculture over the 1960s and 1970s it is remarkable that an emphasis on research capacities, formulated early 1960s by the commission for fundamental research, is difficult to trace in the programme descriptions of the tropical study programmes. The land development programme, for example, provided students the principles of technical solutions. "Because he has to work in primitive circumstances, he will face unforeseen problems. Many of those problems will be of a technical nature. Education at the Agricultural College only provides the basic principles on which technical solutions rest."[88] The focus on professional capacities over research capacities is also something expressed in the programme tropical plant production (*tropische plantenteelt*). "The future demand for graduates is difficult to predict but for the time being enough posts will be available. Individual performance and adequate professional knowledge are often determining for long term future options."[89] This quote also reveals that job opportunities are not any longer a deep concern of the programme designers. In sum, the example of the various programmes relating to tropical agriculture show that the disciplinary differentiation, starting halfway through the 1950s, primarily implied a separation of education programmes and course tracks within programmes. The intended objective of this specialisation, creating more specialised graduates with better research capacities, is not clearly reflected in the description of the programmes and the curricula. From the various sources over the 1970s is given the impression that the academic staff of the Agricultural College was rather satisfied with the education programme. After all, most departments contributed to the curriculum and the students numbers were rising rapidly. The growth of the Agricultural College, in numbers but also in the direction of a real academic institution, seemed to be satisfactory. But accounts from students give another impression.

### Feedback from students

The information from students over the post-war period can be split in two categories. One is the rather large number of written accounts from student sources, discussed below. First the picture will be sketched, based on interviews with Wageningen graduates (twenty-eight in total for this period, of whom the majority graduated in the 1950s). Most graduates followed a programme related to tropical agriculture and all interviewees worked for several years in tropical countries. A first interesting point is that all interviewees graduated early 1950s stated that the independence of Indonesia was not a real concern for them. For five interviewees the motivation for a tropical study was a childhood in the colonies or close relatives with a career in Dutch East Indies. Almost every interviewee expressed the thought they might return to Indonesia. This perspective however was an assumption and for none of the interviewees did it function as a guide to their study. "We were supposed to go to Indonesia and we talked about that, but we never worried about jobs." And someone else said: "During study we never concerned ourselves about careers. The study was interesting, life as a student even more interesting, and we never looked further than that." Another issue raised in the interviews was the coherence of the study programmes. With only

[88] *Programma van het onderwijs* (1965-1966), 176.

[89] *Programma van het onderwijs* (1980-1981), 150.

one or two exceptions the answers expressed that the study was primarily an accumulation of individual courses. Coherence in the programme was something they developed themselves, especially in the later part of the study. "The genetics course was very boring. Only during my field work period I got the impression that it was an interesting discipline." Moreover, every interviewee mentioned several courses that were not considered relevant. "During the second and third year we had to do all kind of experiments that were primarily the professors' hobby." Similar to the responses of graduates who studied in the 1930s, the interviewees of the post-war period all stated that the coherence in their education was mainly an effect of their own choice and interest and hardly a result of the programme structure.

A major difference between interviewees graduated in the period 1950-1965 and graduates from after that period is the kind organisation or firm where they did their field work during the study, and where they worked during their career. Most interviewees graduated before 1965 did their fieldwork in plantation agriculture in Africa, mainly the former British colonies, or in Surinam. "In the period I studied a large part of the education was in plantation agriculture. About one fourth of the group became researchers and the rest agronomists requiring expertise in planting distances, fertilisation and so on." All interviewees mentioned that the knowledge was based on the professors' experience in the Dutch East Indies. This was never considered a problem during the study, but several interviewees stated that in their later career they noticed that it was a bit one-sided. One interviewee told he me was experimenting with sexual propagation of coffee in Kenya. "I wrote to some Wageningen professors for information but they all advised against my experiments because in Indonesia coffee was reproduced vegetatively." The majority of the Wageningen graduates from the period 1950-1965 worked in a public or private research station. In Africa such stations primarily focussed on perennial crops such as cocoa, palm oil, rubber, coffee etc. In Surinam the major focus was rice, more extensively analysed in chapter six. When the decolonisation process set in throughout Africa and in Surinam, implying a gradual transfer of the research and plantation facilities to local staff, most interviewees returned to the Netherlands, many of them finding a job in the Dutch agrarian sector. The interviewees graduated after 1965 all worked for a international (non-governmental) agency, or foreign government, doing all sorts of work related to agriculture. As one interviewee, graduated in the 1950s and professor in Wageningen during the 1970s remarked: "Students were mostly do-gooders, a sort of technical missionaries, swarming out over the world in all kind of projects." This picture is confirmed by a survey of the Wageningen graduate association over sample years 1963 and 1973. The figures of two categories of employment, research institutes and internal organisations plus foreign governments, are telling. In 1963 22.4% of the respondents worked in a research institute, 33.6% for an international organisation or foreign government (n=152). In 1973 these figures were respectively 9.2% and 39.2% (n=260).[90] The figures for the graduates working for an international organisation or a foreign government are further analysed. Respondents are split in two groups, graduated before 1956 and graduated after 1955. Each group was asked if they were posted to the Netherlands, another industrialised country or a developing country. From the group graduated before 1956, 53.5% (n=43) were posted to a developing country in 1963, in 1973 that percentage was 28.2 (n=39). Of the group graduated after 1955 90.3% (n=31) worked in a developing country; in 1963 and in 1973 this was 78.4% (n=116).[91] The change in career perspective for students in tropical agriculture before and after the mid-1960s suggests that professional skills and knowledge became more important from the mid 1960s compared to the previous period. Nevertheless, in answer to the question if they would characterise the education in Wageningen technical or scientific, the large majority of interviewees answered technical, regardless of what year they graduated. Besides the individual accounts of students, gathered by interviews, written sources also express ideas and opinions about the education from students in a more organised form.

**Differentiation versus integration**

From the second half of the 1960s students of the Agricultural College (*Landbouwhogeschool*) in Wageningen organised in various groups and associations. The phenomenon as such was not new, but the student associations from the first half of the twentieth century primarily had a social objective, offering students a place to meet and engage in various activities. The student groups established from the mid 1960s, however, can be characterised as political groups with objectives varying from support of oppressed political minorities in various parts of the world to improvement of the education at the Agricultural College. The emergence of such groups was not confined to Wageningen but present in other universities as well.[92] The variety of issues, these student groups worked on, and the rather high rate of change in membership due to the duration of study, make it difficult to give a balanced account of the ideas and opinions of these groups regarding the education of the Agricultural College. However, one issue that was sustained by various groups as well as by individual students over the 1970s and early 1980s was a plea for so-called project-education. This type of education was based on a formulated problem with an agreed social relevance. Students then started analysing the problem and studied the various issues involved, after which

[90] Van de Heide, *De Wageningse ingenieur in functie*, 102.

[91] Ibid.

[92] Janssen en Voestermans, *Studenten in beweging.*

a possible solution was formulated. Project-education was not just a different didactical form of education but had wider motives. The grounds of students to demand and participate in project-education varied from radical political changes in the relation between science and society and the internal academic relations between staff and students to more moderate objectives of problem solving in concrete situations with ample opportunities for the people involved to participate in the process. Nevertheless, the overall principle for the students was learn to work in project teams and in consultation with people concerned with the issue under study.

Project-education was introduced as a course option in the education programmes of the Agricultural College in 1972. Between 1972 and 1980 77 project teams involving 490 students worked in this study format. The low point in participation was in 1976 with 16 students; 1978 was the peak with 88 students involved in project teams.[93] Total student numbers over the period 1972 to 1980 increased roughly from 3,000 to 6,000, making clear that project-education, in fact (participation in 1978 less than 2%) was not a very popular form of education. Part of the explanation for this low participation, expressed in an evaluation report of 1982, was the politicised and polarised propagation of project-education as a fundamentally better method than all other education methods. "The presentation of project-education as strongly opposed to the existing education enforced the extra-institutional character."[94] But, as argued in the report, project education was never very well organised in the Agricultural College. Although an official commission had to support the project teams, participating students were dependent on the judgement of the regular teaching staff to get a mark and many staff members were not willing to judge a group product where knowledge from outside the discipline was used. "Time and again it appears that teachers in certain fields only strive for disciplinary goals, and only want to mark that."[95] The main conclusion stated in the report was that the politicised positioning of project-education as opposed to the regular education should be reduced and the institutional arrangements improved. Due to various reforms in the academic system in the late 1980s project-education never got a strong foot on the ground in the Agricultural College.

The political ideologies of the student groups in the 1970s and 1980s and the changes in the university system in those decades are the most outstanding characteristics of the rather turbulent and not very successful introduction of project-education.[96] But the arguments of the students against the education at the Agricultural College are more then expressions of radical political views and

[93] Pierik, *Evaluatie van projectonderwijs*, 11.

[94] Ibid., 17.

[95] Ibid., 31.

[96] Faber, *Geschiedenis III*, 151-157.

protests against the government. "Project-education is not so much aimed at acquiring systematically ordered disciplinary knowledge, but only interesting when it contributes to the solution of a concrete societal problem. Moreover, such contribution should clearly be linked to contributions of other disciplines."[97] In the quotation the field of practice where knowledge is gained and applied is not termed 'agriculture' but the more general 'societal problems'. Many issues addressed in the education at the Agricultural College were only vaguely or not at all related to agriculture. The connection between (agricultural) science and this broader context should be broad as well, and not restricted to a single discipline. In the debate about project-education this is called 'inter-disciplinarity' and is in essence a plea for an integrated approach.

## Conclusion

There are two dominating factors in the development of education in agricultural science in the Netherlands. The first concerns the starting point or leading principle of the curriculum, in which two major positions can be distinguished. Over the entire period the development of agricultural education has been followed, there were always voices arguing for agricultural practice as the main guideline for the organisation of scientific agricultural education. In the arguments for such a focus there was a strong emphasis on the broad and complicated character of agricultural practice, requiring an equally broad and integrated approach to the curriculum. The other position emphasised the scientific element. Supporters of this idea argued for a curriculum based on the main scientific disciplines relevant for agriculture and a programme structure that resembled education at a university. Both positions were interpreted and given shape in different ways.

In the nineteenth-century idea of scientific agricultural education the emphasis on agricultural practice was rather prominent. After all, the education was not only about agriculture, but also for agriculture, allowing future farmers advanced study of agriculture. The effect on the curriculum was a simple programme structure in which students were taught a wide variety of aspects of agriculture. The scientific approach was present in various course elements, such as botany, chemistry, physics and so forth. In short, in the nineteenth century scientific education for agriculture had a mixed character, giving space for practical as well as scientific course elements. Early twentieth century the advocates of a scientific approach took a somewhat different stance and pleaded for more emphasis on scientific research, requiring specific skills, the options to specialise in a certain discipline, and a teaching environment that was somewhat protected from agricultural

[97] Pierik, *Evaluatie van projectonderwijs*, 20.

practice. Figures like Kamerlingh and Blaauw gave various suggestions to change the education in that direction. The proponents of more instead of less influence of agricultural practice were mainly graduates from the Wageningen institution, noticing that applying knowledge and skills acquired in their education was a skill in itself. Therefore they argued for a more integrated approach, teaching a sort of agricultural diagnostics, necessary for a proper application of scientific knowledge and technologies. This plea was repeated just after the second world war, resulting in the appointment of a lecturer in general agricultural studies. From the 1950s the scientific approach become more and more dominant. Programmes were split up and more study tracks were formulated, allowing students to specialise in a discipline. The inspiration for the creation of new programmes was primarily the programmes of other academic institutions. The disciplinary differentiation of the post 1950s was challenged again, this time not by graduates but by students. From the early 1970s students demanded the option for 'project-education', pointing out that issues in society, and the people involved in these issues should be the main guidance in setting up education, not the scientific discipline. The fight for project-education was based on the argument that (agricultural) practice should be the main guideline for the organisation of scientific (agricultural) education but this proved no match for proponents of the firmly-established scientific position.

The second dominating factor in the development of scientific education for agriculture is the influence of the organisational structure of the Wageningen institution. Two aspects of this organisational structure play a visible role in the development of the education. First of all, the legal position. The Wageningen institution was created as a school, under the terms of the Middle Education Act. At the turn of the nineteenth and twentieth century it became clear that the school could be included in the system of higher education, formalised in 1918. The legal system demarcated the field in which teachers, professors and managers could operate. But the legal position of the Wageningen institution was exceptional in two ways. Inclusion in the system of higher education did not imply that the former State Agricultural School became a university, but along with other professional schools or colleges it was given a separate status, called *hogescholen*. Besides, the formal responsibility over the Wageningen institution was in the hands of the Directorate of Agriculture, from the 1930s a separate Ministry of Agriculture, resulting in a variety a specific arrangements and interpretations for education in Wageningen. The legal situation enhanced the tension between an orientation of education on science or on (agricultural) practice. A second factor in the organisational structure is the group with which teachers and professors affiliated. In the period from 1876 to the 1950s teachers and professors worked together in a council, from 1918 called senate. The senate was the main group professors could consult and worked with in preparing and implementing various decisions. From the 1950s the influence of the senate diminished, the number of professors raised and the number of academic staff at the departments raised even more. Contact and discussion between professors decreased and interaction between colleagues at the department became the main work-related social activity in the Agricultural College. In other words, the main group professors affiliated themselves with was no longer the senate, but his or her own department. This change in group-affiliation favoured a split of the curriculum over a wide number of programmes and specialised options within the education programmes. The main interest of professors and staff was to get a reasonable number of courses in the programme. The connection between various courses, what students thought about the education, and what career perspectives graduates had, was mainly a concern for the general administration and special commissions.

# 5

# Genetics and plant breeding: wheat in the Netherlands

# Introduction

Improvement and exchange of seed material is a crucial activity in agriculture, although not a very visible activity when observing the farm field. Without an experienced eye it is difficult to tell what specific variety of a crop is sown in a field. The concern in recent years for genetically modified crops and their possible harmful effects on food products have drawn much attention to genetic modification and the new biosciences. The current techniques and options are different from what was available to scientists and farmers in previous decades. Nevertheless, the basic principle - finding or establishing plants with a different genetic make-up with certain desired qualities (in short, plant improvement) - has always kept farmers and scientists busy. The record of farmers in that respect is much longer than that of scientists. The central issue in this chapter is how scientists became involved in plant improvement in the Netherlands, how farmers and scientists joined forces and how plant improvement has developed since. The establishment of genetics and plant breeding in agricultural science covers a considerable number of agricultural crops. For each crop the specific genetic structure, mode of propagation and growth variables determine to a large extent the possibilities and techniques for breeding and research. For reasons of clarity the main crop followed here is wheat, the source of our daily bread. The chapter is divided in three parts. The first covers the early developments in plant improvement. An overall picture will be sketched of the activities of farmers and their organisations in the Netherlands to get better seed varieties. When the State Agricultural School (*Rijkslandbouwschool*) and the State Agricultural Experiment Station (*Rijkslandbouwproefstation*) were opened in Wageningen, several staff members picked up the issue of plant improvement in their education and research activities. This was a rather gradual move, suggesting that science and plant improvement merged rather smoothly. The second part, however, shows that university biologists approached plant improvement too, but in a different way. Besides improvements as such, examples and proof of theories about heredity were major motives for these scientists to get involved in the issue. The different approaches led to different ideas about the organisation of plant breeding, a process agricultural organisations were involved in as well. On the organisational level things seemed well arranged in 1912 with the creation of the Institute for Plant Breeding. However, how to establish the connection between plant improvement in practice and plant improvement as science remained a concern. In the third part the solutions that were found for that problem and how the organisation of scientific plant improvement further developed are described. The last part provides an overview of the developments in the second half of the twentieth century. Although during the 1960s and 1970s the development of genetics and plant breeding in agricultural science developed at a rapid pace, the organisational structure of the various kinds of research and the relation between science and practice were set during the first half of the twentieth century.

## Plant breeding and science

The use of wheat in agricultural activities can be traced back to the beginning of our era.[1] The place of origin of bread wheat (*Triticum aestivum* L.) is most likely near the South-Western corner of the Caspian Sea where it resulted from recurrent hybridisation with a number of other species and varieties. Through trade, travel and other means the grain dispersed to other parts of the world, including Northern Europe.[2] Until about the nineteenth century bread wheat was hardly ever grown in its pure form but mixed with other *Triticum* species like emmer wheat (*T. dicoccum*), einkorn (*T. monococcum*) or spelt (*T. spelta*). Mixtures with very different grains were not an exception either and, for example, a combination grown in the Netherlands of the sixteenth and seventeenth century was wheat and rye (*Secale cereale*), known as *masteluin*.[3] From the seventeenth century historical records provide more information about the role of wheat in Dutch society. A common interpretation from these sources is that wheat was a luxury article, only consumed by elite citizens and by the rest of the population only on special occasions.[4] This conclusion holds for areas where wheat was hardly cultivated, but in regions where wheat was commonly grown, mostly marine or river clay soils, it was part of the daily diet of all social strata.[5] Even in a small country like the Netherlands, regional differences can be quite big and this is reflected in the various cultivated wheat varieties and combinations with other cereals.

[1] Purseglove, *Tropical Crops; monocotyledons*, 291. Slicher van Bath, The agrarian history of Western Europe.

[2] Gooding and Davies, *Wheat Production and Utilization*.

[3] Zeven, *Landraces and improved cultivars*, 2.

[4] Van Otterloo, *Eten en eetlust*, 18-19; Jongerden en Ruivenkamp, *Patronen van verscheidenheid*, 92.

[5] De Vries, "The production and consumption of wheat", 201.

**Table 1: Wheat types. (Source: Gooding and Davies, *Wheat production and utilization*, 16.)**

| Ploidy level | Scientific name | Common name(s) |
|---|---|---|
| Diploïde | *T. uratu* Tum. | Wild einkorn |
| | *T. boeoticum* Bioss. (spp. *Aegilopoides* spp. *Thaoudar*) | Wild einkorn |
| | *T. monococcum* L. | Cultivated einkorn |
| | *T. sinskajae* A. Filat & Kurk. | Cultivated einkorn |
| Tetraploïde | *T. dicoccoides* (Korn) Schweinf. | |
| | *T. dicoccum* (Schrank). Schulb. | Wild emmer |
| | *T. paleocolchicum* Men. | Cultivated emmer |
| | *T, carthlicum* Nevski | |
| | *T. turgidum* L. | Persian wheat |
| | *T. polonicum* L. | Rivet or cone wheat |
| | *T. durum* Desf. | Polish wheat |
| | *T. turanicum* Jakobz. | Durum or macaroni wheat |
| | *T. araraticum* Jakobz. | Khorasan wheat |
| | *T. timopheevi* Zhuk. | Wild emmer |
| Hexaploïde | *T. spelta* L. | Spelt or dinkel |
| | *T. vavilovi* (Tum.) Jakobz. | Spelt |
| | *T. macha* Dek en Men. | Spelt |
| | *T. sphaerococcum* Perc. | Indian dwarf or shot wheat |
| | *T. compactum* Host. | Club wheat |
| | *T. aestivum* L. | Bread or common wheat |

The adaptation of wheat to the cultural and ecological environments of different areas resulted in so-called landraces of wheat. Information on these landraces is available from the late eighteenth century onwards, provided by botanists who described the botanical differences between species and varieties. More insight in the variation of wheat types grown in the Netherlands was given by the overviews of the provincial commissions of agriculture. These commissions were established by the republican government of the late eighteenth and early nineteenth century and had to report to the National Agent for Agriculture, Jan Kops (1765-1849).[6] Kops published the overviews in the so-called States of Agriculture (*Staten van Landbouw*) the first national statistical records of agriculture. Despite the amount of information it is still very difficult to distinguish the specific features of certain landraces. There are differences in morphological characters (like short or tall, red- or white-chaffed, pubescent or glabrous, red or white grains), sowing time (winter or spring wheat), use (bread, batter or feed) or level of adaptation. Farmers, traders

[6] See chapters 2 and 7.

and millers were probably well familiar with the differences on the local level but local characteristics are not always useful for national comparisons. Farmers in province of Utrecht for example preferred red-grained varieties because purple cow-wheat (*Melampyrum arvense*) was a persistent weed in this area. Pollution of the harvest with the weed seeds was less obvious when the lot was red grained.[7]

Based on adaptation level and morphological characteristics four different landrace groups can be distinguished that were grown during the nineteenth century (see Table 2). Although a landrace is a local phenomenon wheat farmers often purchased seed material from other regions in the Netherlands or abroad, most prominently Britain, the German states, the Baltic region and Sweden. Exchange of seed material was further stimulated by private farmer organisations and national societies. The Wittington variety for example, introduced in the Netherlands in 1839, looked so promising that the Society for General Industries (*Algemeene Maatschappij van Nijverheid*) organized a competition for the best description of the cultivation of this variety in two successive years. Wittington is the Dutch spelling of a cultivar (Var. albidum), collected in Switzerland by an Englishman Whittington. It was a popular variety around 1850, but declined after 1855. The involvement of agricultural organisations did not directly imply more accurate distinguishing of varieties. Zeven notes that two specimens of Wittington and enclosed annotations in the Leiden Herbarium suggest that the Wittington variety grown in the Netherlands might not be derived from the Swiss cultivar at all, but may have been selected from the *Zeeuwse* landrace group.[8] Another example of organised forms of plant improvement in the nineteenth century is the annual meeting of agricultural organisations, the Land-household Studies Congress (*Landhuishoudkundig Congres*) a popular occasion for exchange of material and information on the latest improvements. In the meeting of 1862, for example, a question was raised about the performance of different sorts of wheat. Many of the members present answered the question with descriptions of the variety grown in their region, the soil type, storage, baking quality and other aspects.[9] These examples show that the interest in and exchange of better performing (wheat) varieties was a general concern of farmers and agricultural societies. Seed exchange, however, was not a real organised phenomenon, but the result of various activities. Farmers exchanged seed material with their neighbours, or relatives in other regions, or bought seed from traders. Besides exchange, farmers improved their crop by selecting the best performing plants as seed for the next season. Although probably all farmers applied some form of selection on the seed material, in most regions a few farmers specialised in the selection and multiplication of sowing seed and supplied other local farmers.

[7] Troost, "Overzicht van de in ons land verbouwde tarwerassen", 232.

[8] Ibid., 233. Zeven, *Landraces and improved cultivars*, 95.

[9] *Verslagen Landhuishoudkundig Congres* (1860), 134.

Regarding wheat, the techniques for plant improvement were all based on selection. Only in the late nineteenth century some of these specialised farmer-breeders detected the minuscule inflorescence and mating process of wheat and managed to make artificial crossings.

## Skill and science cross

The concern for plant improvement was one of the issues taken up by the State Agricultural School, *Rijkslandbouwschool,* and the State Agricultural Research Station, *Rijkslandbouwproefstation*, in Wageningen in the late 1870s. These two connected institutes were created by the Dutch state to support the agrarian population with quality control, research, innovations and scientific education in agriculture. The main task of the experiment station was analysing samples of all kind of agricultural products and inputs, including sowing seed. Seed samples were tested on uniformity, contamination, moisture content and some other features. For each analysed sample the station wrote a certificate with the test results.[10] The number of analyses increased every year and in 1898 the seed department of the Wageningen Experiment Station was converted into a separate State Experiment Station for Seed Control, *Rijksproefstation voor Zaadcontrole*. The control of agricultural inputs and products resulted in a certain quality standard, reducing the risk for farmers to become a victim of fraudulent traders and vice versa, but also resulted in knowledge about the composition and behaviour of all sorts of organic products. Nevertheless, control analysis is a rather passive contribution of science to agricultural improvement, selecting out bad elements but hardly contributing with innovations. Although the experiment station had an explicit task in research resulting in innovations for agriculture, regarding seed material the main contribution in that respect came from teachers of the State Agricultural School. Next to the central building of the school in Wageningen was a small garden where several crops were grown for educational and experimental purposes. From the late 1870s three teachers started with breeding experiments on various crops, Martinus Willem Beijerinck (1851-1931), Luitje Broekema (1850-1936), and Johann Otto Franz Pitsch (1842-1939). The three teachers worked together on several crops and issues. Nevertheless, there is a difference in background and motivation between Beijerinck on the one hand and Broekema and Pitsch on the other. The background and position of Beijerink is further explained in the next section. The background and activities of Broekema and Pitsch fit the argument of this paragraph.

Luitje Broekema was born in the Groningen province, the son of a farmer. He went to Leiden University to study mathematics and physics. After some years in Leiden he applied for a study grant offered by the government to get an academic degree in agriculture at a foreign university in order to staff the State Agricultural

[10] *Inventaris van het archief van Het Rijksproefstation voor Zaadcontrole.*

School with qualified teachers. He was one of the very few selected and went to Halle in Germany to study agronomy. He was appointed as teacher in plant breeding, cattle breeding and dairy farming at the school in Wageningen in 1877 and in 1885 he was appointed as director of the School.[11] The German teacher Otto Pitsch had a similar background. He also stemmed from a farming family, studied agronomy at the agricultural academy in Poppelsdorf and received a doctorate at the university of Heidelberg. He was inspector on an estate in East Prussia and *Wanderlehrer*, a travelling instructor in agriculture in the Rhine Province. In 1870 he was appointed in the Netherlands at an agricultural school in the North and invited to teach general agronomy in Wageningen in 1876.[12] Broekema and Pitsch used the garden of the school to experiment with various crops, but they also made use of the institutes related to the school in Wageningen. An important facility in this respect was the Extension Service, created in 1892 and staffed with Wageningen graduates. The extension officers were divided over several regions covering the Netherlands and assigned a number of tasks, including field tests.[13] The Extension Service gave Broekema and Pitsch the opportunity to have the crosses and selections form their experiments tested by their former students in different conditions.[14] The testing in different conditions was crucial in getting information about heredity and performance. Broekema therefore also sent seed samples to his father and other farmers he knew personally to test the products of his breeding work. The activities of Broekema and Pitsch can be illustrated by their work on wheat.

In 1886 Broekema crossed two varieties, *Rode Dikkop* (Red Squarehead, Var. *lutescens*) with the landrace *Zeeuwse* (Var. *albidum*). Broekema aimed to combine the productivity of Squarehead with the better grain quality of *Zeeuwse*, also paying attention to straw stiffness and winter hardiness. After further selection the cross delivered two well producing types that became widely cultivated in the Netherlands, *Duivendaal* and *Spijk*, named after the model farm and experimental garden from the Wageningen school. In the same period Pitsch was working on a cross between Rough Chaffed Essex (Var. *leucospermum*) with the French landrace *Blé rouge inversable* (Var. *albidum*), with he called *Bordeaux-bastaard* or *Essex-bastaard*. For many years the breeders had these varieties tested by farmers and agricultural consultants. The information was used for further selection of the varieties. In 1899 Broekema back-crossed his varieties *Duivendaal* and *Spijk* with Red Squarehead. From this cross he obtained a very high performing variety that he named after the Dutch queen Wilhelmina.[15] As figure 1

[11] Van der Burg, "In Memoriam Prof. Dr. L. Broekema."

[12] B., "Prof.Dr. Otto Pitsch." Van der Haar, *Geschiedenis I.*

[13] See chapter 7.

[14] Broekema, "Duivendaal- en Spijktarwe." Pitsch, "Ervaringen, opgedaan en resultaten, verkregen."

[15] Ibid. De Haan, "Wheat breeding in the Netherlands."

shows, this variety was a principal genetic source for the wheat varieties grown in the Netherlands in the first half of the twentieth century.

**Table 2: Landraces of wheat grown in the Netherlands in the 19th century. (Source: Zeven, *Landraces and improved cultivars.*)**

| | **Zeeuwse** | **Rough chaff Essex** | **Gelderse** | **Ruige Kleefse** |
|---|---|---|---|---|
| **Main features** | No awns, white and sleek chaff, white grain, limited winter-hardy (var. *albidum*) | No awns, hairy and white chaff, white grain (var. *Leucospermum)* | No awns, red or white haired chaff, red grain (var. *Milturum)* | Like Gelderse, but with awns (var. *ferrugineum/ erythrospermum*) |
| **Names** | Chiddam, Engelse Witte, Essex Gladkaf, Goese, Hundredfold, Rouselaere, Smooth Chaffed Essex, Walcherse, White Essex, Witte Engelse Essex, (Witte) Victoria, Witte van Vlaanderen, Zeeuwse, Zeeuws Vlaamse and synonyms. | Blanc à duvet, Essex Ruwkaf, Fluweelkaf, Ruwkaf Essex, White Essex and synonyms. | Deris, Clevelandse, Friese, Gelderse (Ris), Gelderse Rode, Gladde Ris, (Groninger) Oldambtster, (Groninger) Ommelander, Klare Ristarwe uit Kleefsland, Kleefse, Limburger, Limburgse (kleine) rode, Rosse tarwe and synonyms. | Angelris, Clever Hochland Weizen, Echeltarwe, (Rode) Hooglandse, Kleefse Ruwharige, Rode Baard, (Rode) gebaarde Kleefse, Rode tarwe Westland, Ruigarige, Ruige tarwe and synonyms. |

The example makes clear that Broekema and Pitsch mastered the skill of emasculation and manual pollination of wheat, but other breeders in the Netherlands had the capacity as well. Besides, exchange of seed material and experience between the Wageningen breeders and private breeders was rather common in those days.[16] For example, a breeder in Groningen province, J.H. Mansholt (1840-1914), received some seed material of Broekema's cross *Dikkop* with *Zeeuwse*, from which he selected two varieties grown on considerable scale in the north, *Lange Witte Dikkop* and *Korte Witte Dikkop*. The example also makes clear that crosses and varieties were not homogeneous in genetic make-up, a

[16] Dorst, "Development and organization of the breeding."

well-known and exploited feature. One of the reasons for the success of the Wilhelmina variety was because it was a blend of a few different lines, which made it well adaptable to varying conditions. In sum, the activities in plant improvement performed by Broekema and Pitsch dovetailed with the breeding activities of specialised farmer-breeders and private seed companies in the Netherlands. As we shall see further on, both teachers had a clear scientific interest as well but their main aim was to serve the agrarian sector with better performing varieties. The breeders tried to get as much information about the varieties as possible but whether the information they received about their products was correct or not was primarily a matter of confidence and trust. The trade in varieties was free, and Broekema did not receive any royalties until the late 1910s.

## Science and plant breeding

The interest and active participation in plant improvement by the teachers from the State Agricultural School was not the only encounter between science and plant breeding. Tinkering with the reproduction of plants was also followed and actively practised by biologists. The background of this interest and experimenting was the publication in 1859 by the British naturalist Charles Darwin of his book *The origin of species*. According to Darwin species were created by evolution, based on variety within species, the transmission of variations to succeeding generations and the selection of the natural environment on these variations. Although the reproductive process was essential in his theory, Darwin was not very clear about inheritance, and biologists taking up his main argument considered a concept of heredity as one of the main challenges for the future.[17] Darwin's formulation of a theory of evolution not only explains the growing interest in heredity but also resolves the interest of biologists in the work of practical breeders. One of the founding elements in Darwin's theory was crossing between species, the so-called hybrids or bastards, and between varieties within species. The general perception of most naturalists in those days was that species were constant forms, made by the Creator, each with a place in the natural order. From that perspective hybrids were considered unnatural and the fact that many hybrids were sterile or reverted to one of the parental forms after some generations, supported this view. The point that transmutation is artificial, not a creative natural mechanism, and thus cannot explain the origin of species was often used against Darwin's theory.[18] Darwin's counter-argument was that infertility was not an essential feature of inter-specific crossings, but merely a transformation of the sex organs that could appear (or not) just as any other character. A distinction

[17] Allen, *Life science in the twentieth century*, 52.

[18] Kimmelman, *A progressive era discipline*.

between species and varieties therefore was gradual and not essential.[19] Moreover, from the point that species formation is the result of gradual adaptation of slightly differentiating characters under changed conditions, crossing between slightly different varieties of the same species was far more interesting then crosses between dissimilar species. For that reason Darwin and his followers were highly interested in the activities of pet breeders, gardeners and other amateurs, who mirrored and mimicked a natural process by which new species were produced.

Darwin's theory was a radically new interpretation of the origin of species and botanists, zoologists and others were in most cases either fervent adherents or ardent opponents. In the Netherlands the dividing line between the two opposing views ran more or less between two generations of biologists. Where their professors generally rejected or simply paid no attention to Darwin's ideas, students in the 1860s and 1870s were rather enthusiastic. Among these students were several who went on to make successful careers in biology.[20] Four of them, M.W. Beijerinck (1851-1931), J.H. van 't Hoff (1852-1911), J.W. Moll (1851-1933) and H. de Vries (1848-1935) became professors at Dutch universities. Another, M. Treub (1851-1910), became director of the Botanic Garden in Buitenzorg on Java. Especially Hugo de Vries, professor at the University of Amsterdam from 1878, was a clear devotee of Darwin and spent much of his time on the study of heredity in plants. Similar to Darwin, De Vries was also very much interested in the work of practical breeders.[21] Before the involvement of De Vries in plant breeding is further examined, some attention is given to the career and activities of another of the biology students of De Vries' generation, the third of the early plant experimentalists at Wageningen.

A colleague of Broekema and Pitch at the State Agricultural School was M.W. Beijerinck. Martinus Beijerinck grew up in Haarlem as a son of a railway clerk. His father sent him to the Delft Polytechnic to study chemical engineering and later he went to Leiden to study botany. In 1876 Beijerinck accepted the position of botany teacher at the State Agricultural School in Wageningen. During his Wageningen period Beijerinck experimented with wheat varieties, crossed and analysed in order to trace back the origin of wheat, something he continued to be interested in after he left Wageningen in 1885.[22] One of he methods he used was noting down meticulously all the characteristics of the parental plants and offspring, looking for numerical patterns in the hereditary characters, i.e. the segregation ratios. In 1900 it was rediscovered that Gregor Mendel (1822-1884) had formulated already in 1865 a simple but effective formula for the segregation ratios of hereditary characters. The

[19] Ibid., 86.

[20] Hagendijk, *Wetenschap, constructivisme en cultuur*, 169.

[21] Theunissen, "De beheersing van Mutaties." Theunissen, "Knowledge is Power."

[22] Van der Haar, Geschiedenis I, 64-66. Zeven, "Martinus Willem Beijerinck: a hybridizer." Theunissen, "The beginnings of the "Delft tradition."

credit for the rediscovery of Mendel's laws are shared between the biologists Hugo de Vries, Carl Correns and Erich von Tschermak. More important, however, is the shared interest in these principles by biologists all over the world. In Wageningen Beijerink also put Broekema on the track of studying segregation ratios.[23] Equally so, Beijerink not only looked at theoretical implications of plant breeding but actively promoted crossing as an important method for the improvement of agricultural crops. In other words, interest and activities were shared between biologists with primarily theoretical objectives and agronomists like Broekema and Pitsch who mainly aimed at improvement of agricultural crops. Especially when the working environment was shared, as in Wageningen in the late 1870s and early 1880s, these different opbjectives combined rather well. But it was exactly the creation of a proper work environment for the development of plant breeding that became a source of conflict between biologists and agronomists.

### Organising plant breeding

In the first decade of the twentieth century the organisation of plant breeding in the Netherlands became the subject of a debate between various parties. Central in this discussion was a foreign breeding institute however. The biology professors Hugo de Vries in Amsterdam and Jan Willem Moll in Groningen considered the work of a colleague in Sweden, Hjalmar Nilsson, as the example for the way science could serve agriculture. For De Vries there was another reason to promote the work of Nilsson. In the early 1900s De Vries published his theory of mutations, with which he claimed to have solved Darwin's problematic connection between heredity and evolution.[24] The basic assumption of this theory was that differentiation within species, resulting in new species, was not a gradual process but the result of sudden changes, mutations. The main evidence for this theory came from De Vries' experiments with primroses (*Oenothera spp.*) but he also discussed the work of other researchers that might support his theory. In a publication of 1907 he extensively described the horticultural experiments of Luther Burbank in the USA and the work on cereals of N.H. Nilsson at the Swedish Society for the Improvement of Sowing-seed at Svalöf.[25] Hjalmar Nilsson, appointed in 1890 by the mentioned society as director of the plant breeding station, set up a selection programme in which he sorted out 'elementary species' from several populations of grains. Nilsson was particularly interested in the relation between botanical features and functional traits. Meticulously recording all his observations, Nilsson found some very high performing atypical forms. De Vries argued that the deviant types Nilsson found resulted from mutations. The activities of Nilsson, therefore, not only supported De

[23] Zeven, "L. Broekema's segregation ratios." *Jaarboek Lh* (1922), 69.

[24] Allen, *Life science in the twentieth century*. Falk, "The struggle of genetics for independence."

[25] De Vries, *Plant breeding.*

Vries' theory but also made clear that the theory of mutation was very fruitful for application in agriculture, resulting in new and better performing crops. "They are founded on the principle of single selections, and the range of application of this method is proven to be so extensive as to make all ideas of repeated or continuous selection simply superfluous. It is even so rich in its productiveness that there is scarcely any room left for other methods of improvement; and especially all endeavors of winning ameliorated varieties of cereals by means of hybridization should be left out of consideration, as compared with the immense number of more easily produced novelties which this method offers."[26]

De Vries' interest in this Swedish institution was picked up by several organizations in the Netherlands. In 1908 the Holland Society for Agriculture (*Hollandsche Maatschappij van Landbouw*) held a competition for the best description of the breeding activities at Svalöf. The winner was a botany student from Amsterdam.[27] The Groningen Society for Higher Agricultural Education (*Vereeniging voor Hoger Landbouwonderwijs*) - with professor Moll one of its prominent members - invited Hjalmar Nilsson for a series of lectures at Groningen University, and asked him to advise on the creation of a breeding station for the Netherlands, similar to the one in Svalöf.[28] The Groningen Society for Agriculture and Industries was interested, too, and together with the education society they formed a commission consisting of a farmer, a breeder and a botanist, that visited Svalöf in August 1909.[29] One of the questions raised by the commission was why the Netherlands did not yet have an institute similar to the breeding station in Svalöf. According to the commission this was primarily a result of the difference in wealth between the farming population in Sweden and in the Netherlands. The percentage of tenants in the Netherlands was 45%, compared to 15% in Sweden, and the number of large landowners (over 100 hectares) in the Netherlands was less then 200 compared to more then 3000 in Sweden. Moreover, they explained that in the Netherlands the response to the agricultural crisis of the 1880s was primarily improvement of soil fertility, and this overshadowed the attention for crop improvement.[30] The commission advised to create a similar organisation for plant breeding in the Netherlands as in Sweden. A Society for the Improvement of Sowing-Seed in the Netherlands should oversee a breeding station, both related to a Dutch Breeders Association. This would obtain the exclusive right to reproduce the seed material produced by the station and determine the rules associated breeders should follow in multiplying and selling seeds.[31] The interest in the Swedish breeding

[26] Ibid., 50.

[27] Tjebbes, "Antwoord."

[28] Addens, *Vereeniging voor hooger landbouwonderwijs*, 235.

[29] Dojes, Mansholt en van Harreveld, *Rapport over de veredeling van Zaaizaad.*

[30] Ibid., 16-18.

[31] Ibid., 31-32.

station was not only based on scientific arguments. Swedish varieties of wheat and other grains were well-known and widely grown among Dutch farmers, especially in the Northern provinces. The ideas of De Vries and the initiative of the Groningen societies, therefore, were not entirely surprising.

The teachers of the State Agricultural School in Wageningen involved in plant improvement were familiar with the Swedish breeding station as well. Although positive about the station in Svalöf, there was scepticism about the arguments of Hugo de Vries. The clearest expression of this came from Otto Pitsch. Pitch was not convinced by De Vries' theoretical claims. "After all, that the elementary species of the primrose, obtained by De Vries in his garden, did spring from mutations, is doubted, although H. de Vries is absolutely convinced of it. It is very difficult though, to determine if traits of a variety are the result of crossing or of mutation."[32] Pitsch stressed that crossing is a very valuable technique, not only as a means to produce better varieties, but also, referring to the work of Mendel, to find out how certain traits descend in subsequent generations.[33] Regarding the work of Nilsson at the Swedish breeding station Pitsch argued his success was not based on mutating species but on a profound and extensive method of recording all traits and abnormalities of varieties, in combination with plain luck.[34] For Pitsch, his and Broekema's breeding work was basically the same kind of work as performed by Nillsson, except for the facilities being far better at the station in Svalöf. Pitsch ended with a plea for more financial investment in plant breeding.

Despite the differences in argumentation, the breeders from Wageningen and Groniningen agreed that the government should give financial support for the creation of a breeding institute. The Director-General of Agriculture, P. van Hoek (1865-1926) decided to bring the two parties together and in November 1910 a meeting was arranged in Zwolle, halfway between Wageningen and Groningen, where delegations of the Groningen society, the school, and the Experiment Station for Seed Control from Wageningen discussed the options. The decision made in the meeting was that an Institute for Plant Breeding would be attached to the school in Wageningen.[35] Contrary to the organisation in Sweden the multiplication and distribution of seed would be left in hands of the provincial agricultural societies and private breeders. Because agricultural organisations could not raise the financial means, the state took care of all the costs of the institute. The Minister of Agriculture ratified the regulations in September 1912 and in October of the same year the Institute for the Improvement of Agricultural crops (*Instituut voor de Veredeling van Landbouwgewassen*) soon renamed as Institute for Plant Breeding (*Instituut voor*

[32] Pitsch, "Waarheen."

[33] Ibid., 94-95.

[34] Ibid., 61-62. Mansholt, "De Svalöfsche kweekmethode en die van andere kweekers."

[35] Addens, *Vereeniging voor hooger landbouwonderwijs*, 237-238; Pitsch, Toelichting tot het "Totstandkomen en tot het werkprogram."

*Plantenveredeling* - IvP) was opened in Wageningen. The first director was Otto Pitsch, aged sixty-nine.

**Creating authority**

From 1912 there were two institutes in Wageningen related to the seed sector, the Experiment Station for Seed Control and the Institute for Plant Breeding (IvP). The main objective of the IvP was breeding varieties that are valuable for agriculture. Further listed were scientific research, field tests, providing information, acknowledgement, control and maintenance of superior varieties, and maintaining valuable varieties. The control function of the IvP was different from that of the control station. The latter controlled the quality of seed by analysing samples in terms of germinative power, moisture, homogeneity and so on. The weighing, drying and analysis of the samples required precise instruments, chemicals, knowledge and skill in organic chemistry and plant physiology. The activities of the control station were performed in a laboratory setting. The Institute for Plant Breeding was primarily interested in the botanical features of seed, the type, its agronomic and processing qualities. The IvP performed its analyses on the field, studying features of the plant while it was growing and noting down the features of the crops after it was harvested. Besides botanical knowledge the work required a well-trained eye. The workspace of the IvP was in fact the entire area grown with crops. Otto Pitsch explained that for the realisation of its objectives the IvP depended on the co-operation of extension officers, breeders and farmers.[36] Contrary to the Swedish situation, multiplication and control of the varieties was not organised in a single corporate body. In fact, most provincial agricultural organisations had created their own control systems around the turn of the nineteenth and twentieth century. Already in the 1880s several of these organisations started with exhibitions in which prices were awarded to the best seed lots. The Agricultural Society of Friesland was the first to create a permanent committee for seed inspection in 1903. The committee not only analysed seed samples, but also inspected the crops in the field where "detailed description is made of the condition and authenticity of the crop, the soil type, fertilisation of the soil and everything that can influence the shape of the crop."[37] Between 1910 and 1914 the other provincial societies followed with similar inspection committees. What varieties were inspected was mainly determined by supply of varieties produced by the IvP or private breeding companies and the demand of farmers for certain qualities.

Similar to the certificates issued by the Experiment Station for Seed Control, the IvP launched an official certificate for crop varieties.[38] If a breeder wanted his new

[36] Ibid.

[37] Addens, *Zaaizaad en pootgoed,*118.

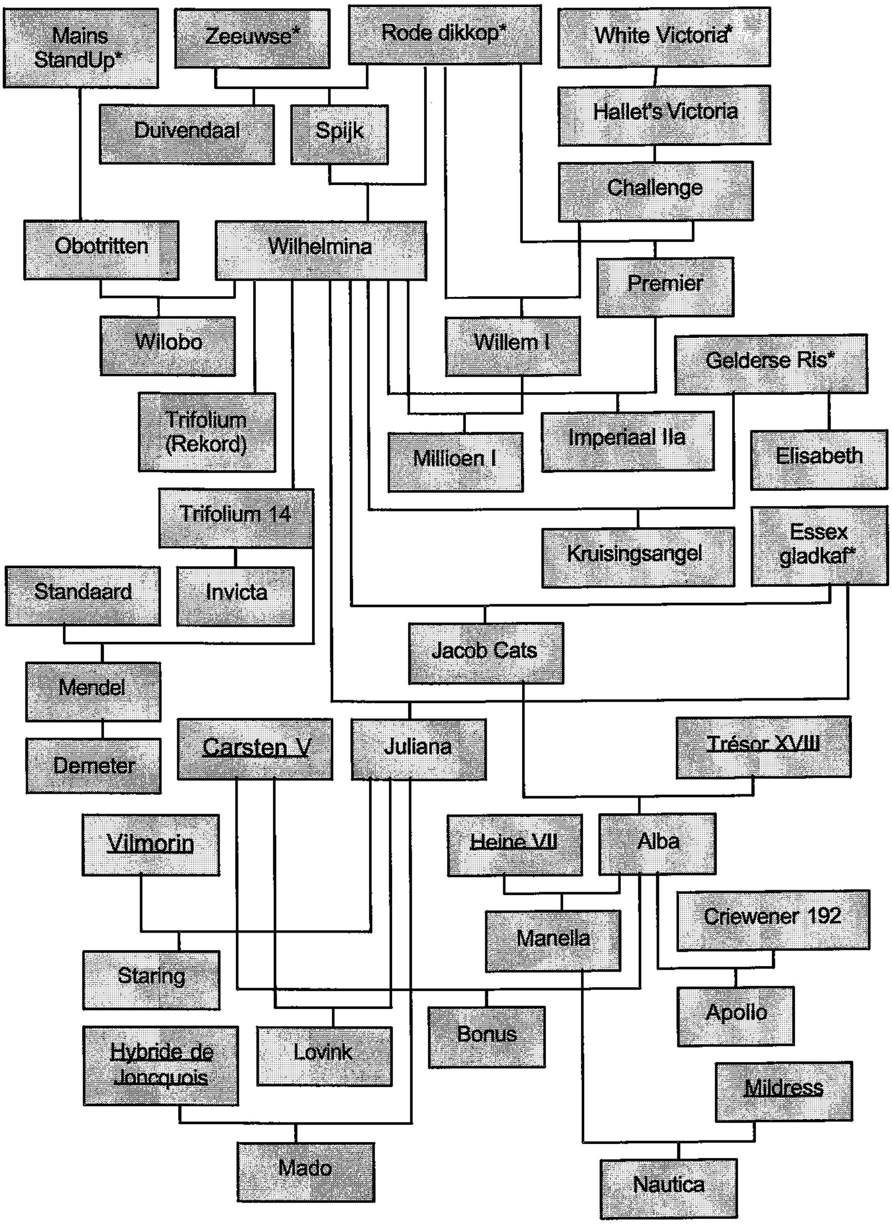
[38] "Reglement betreffende de erkenning."

variety officially recognised and registered, the IvP tested the variety in the field. The breeder had to prove that he could maintain the variety and had to inform the IvP where and by whom the variety was multiplied. But unlike the control station the IvP could not organise and perform the analysis in a central and controlled laboratory environment. Therefore the IvP applied a double strategy. First, the field tests of varieties performed by the Extension Service were regulated and intensified. The extension officers had considerable freedom in their work, and especially for the field trials there was no uniform procedure. Already from 1904 the Directorate of Agriculture (*Directie van Landbouw*) tried to establish uniform procedures for field experimental tests but extension officers were not convinced that new methods were more accurate than what they had applied for years.[39] The main thing the IvP could do was to prescribe experiments with crop varieties in the hope that the officers of the Extension Service extension officers followed the instructions. However, aligning and harmonising the field test procedures was not entirely just a matter of organisation. An important reason for the fact that different agricultural consultants applied different test procedures was because there was no basic agreement about how a field experiment would result in reliable data. Small variations in the many factors influencing plant growth were impossible to isolate physically. The only solution was to perform many experiments, and calculate averages, deviations and error rates. In other words, the value of field trials depended on the application of a proper statistical methodology and in the first decades of the century mathematicians and agricultural scientists were still puzzling about this.[40]

[39] Addens *Zaaizaad en pootgoed*, 110.

[40] See chapter 7.

**Figure 1:** Wheat varieties released in the Netherlands until the 1970s. Varieties marked with * are landraces. Underlined varieties are imported. (Source: Van den Berg, *Oude en nieuwe tarwerassen*. Zeven, *Landraces and improved cultivars*.)



For the IvP this implied that its scientific credentials not only lay in botanical knowledge and breeding skill but also in mathematical statistics. As long as reliable and agreed methods were lacking, the scientific method itself could not create sufficient confidence in the IvP.

The second element in the process of creating authority for the Institute for Plant Breeding was relying on the administrative power of the national government. A major concern in the process of analyses and control of crop varieties was not to distinguish between different varieties, but to determine similarity between different lots of seed of the same variety. The inspection committees of the provincial agricultural organisations, therefore, examined the work of farmers and companies multiplying and selling seed. The committees not only examined the crop before and after the harvest, but also the production method and credentials of the seed producer. Each provincial association had developed its own criteria and standards and the IvP had no tools or procedures at hand to override these differences. It was the Directorate of Agriculture that took the initiative to regulate inspection for seed multiplication. In July 1915 Director-General Van Hoek organised a meeting with the provincial farmer associations to discuss the question of how "'to obtain unity in inspection and to realise a well organised foreign trade in sowing seed.'"[41] All parties expressed the need for a centrally defined standard for inspection, but they could not agree on details and conditions and it was decided to meet again next year. After four years of negotiation an arrangement was made between the different parties, formalised in the creation of a Central Committee for Crop Inspection. The Central Committee had the legal status of a private association, seated in Wageningen, with two sorts of members. The ordinary members were the provincial farmer organisations and the other category, the advising members, consisted of the Institute for Plant Breeding, the Institute for Phytopathology and the Research Station for Seed Control.[42] Originating from the farmer organisations, the Central Committee for Crop Inspection was considered to represent a one-sided interest in the eyes of Dutch seed traders and in the same year they set up their own inspection service (*Algemeen Keuringsinstituut van de Bond van Nederlandse Handelaren in Zaaigraan, Zaaizaad en Pootgoed*, KIZ). The conflicts between the inspection agencies of seed companies and farmer organisations lasted for many years and even the scientific institutions in Wageningen were divided. The samples analysed by the Experiment Station for Seed Control primarily came from seed traders, where the IvP mainly interacted with representatives of the provincial agricultural organisations. In September 1919 the director of the station cancelled all his meetings with the Central Committee because of its negative stance towards the seed traders.[43]

[41] Addens, *Zaaizaad en pootgoed*, 122.

[42] Kakebeeke en Louwes, *Concept-Statuten van de Vereeniging*. Addens, *Zaaizaad en pootgoed*, 124.

[43] Addens, *Zaaizaad en pootgoed*, 153.

The conflict over the organisation of seed inspection makes clear that the two activities, development of plant breeding as a scientific discipline and the organisation of the seed sector, were entirely mixed up in the first decades of the twentieth century. A major reason for this entanglement was because the Institute for Plant Breeding had no exclusive knowledge or method available that allowed it to become the centre of expertise in the seed sector. However, the involvement of the Experiment Station for Seed Control, an institute using methods and equipment that was far more exclusive in the Netherlands, shows that involvement in policy issues was not something that was avoided as much as possible but sought out openly and actively by representatives of the scientific institutes.

**Creating space for research**

In 1918 the State Agricultural School was integrated in the Dutch system of Higher Education and renamed as an Agricultural College (*Landbouwhoogeschool*). In the reorganisation accompanying the event Pitsch was retired. The newly installed senate of the Agricultural University charged a commission of five professors to advise about a new professor in plant breeding and director for the IvP.[44] The senate commssion put H. Nilsson-Ehle first on the list of candidates and secondly J.A. Honing. Nilsson-Ehle was professor in botany and plant breeding at the University of Lund, Sweden. Previously he was director of the plant breeding station in Svalöf as successor of Hjalmar Nilsson.[45] Nilsson-Ehle informed the senate that he was interested but because he already had a professorial position he requested for a discussion about the job offer. In the aftermath of the first World War travelling from Sweden to the Netherlands was rather complicated and the journey was postponed several times. In March 1919 the Minister responsible for agricultural affairs wrote to the senate that it was taking too long and that negotiations with Nilsson-Ehle had to be cancelled.[46] The college board asked the senate commission for a new advice and this time the commission included with the names a proposal to reorganise the institute and give up all the activities related to the organisation and regulation of the breeding sector. "Because these activities, among other things consisting of field inspections, control of seed associations, acknowledgement of varieties and control of breeder-owners of certified varieties, are not considered to be necessary for the development of agricultural science or in service of higher agricultural education at the Agricultural College, but have merely a direct linkage with the demands and wishes of agricultural practice, while it more and more obstructs the activities of the Director-Professor for science and education, the Committee unanimously thinks

[44] *Archive Lh*, 2415.

[45] Ibid. Roll-Hansen, "The genotype Theory of Wilhelm Johannsen."

[46] *Archive Lh*, 2415.

that the mentioned activities should be split off from the Institute."[47] What remained was an Institute for Arable Farming and an Institute for General Genetics. For the latter position the committee put forward J.A. Honing as the first candidate, and as a second candidate Tine Tammes, one of the first prominent female academics in the Netherlands.[48]

Jan Antonie Honing (1880-1950) studied at the University of Utrecht and did his doctorate thesis under guidance of Hugo de Vries in Amsterdam. He left for the Dutch East Indies in 1909 to work on tobacco at the Deli Research Station at Medan, Sumatra. He rose to the highest position in the station and when the senate commission approached him about the job, he had been director for two years. Honing replied to the commission that he accepted the chair but had "no desire to lead a research station for another 30 years."[49] His wishes were granted and in January 1920 he was appointed as professor in genetics without any formal attachment to the Institute for Plant Breeding. A year later the combined chair in plant breeding and directorship of the IvP were still vacant and the board of trustees of the college suggested to approach C. Broekema, director of the Groningen Seed Association. Cornelus Broekema (1883-1940), son of the Wageningen teacher L. Broekema, studied at his father's school. He followed lectures in zoology in Zurich for several years after which he worked for different agricultural organisations.[50] Broekema was interested in the job, although he asked for some extra time to further inform himself about plant sciences because "my scientific education was more in the field of cattle breeding then in plant breeding".[51] Apparently that was no problem and in April 1923 he was appointed professor in Plant Breeding and director of the Institute for Plant Breeding.

The refusal of Honing to manage a research institute thwarted the plans of the senate commission to reorganise the IvP, but at least one prominent researcher was enlisted for education and research on genetics. The archive records give no full explanation why Broekema, who did not have a doctorate, was requested for the chair in plant breeding, but most likely his experience in management acquired at several agricultural organisations convinced the senate. This explanation is sustained by the fact that a major researcher of the IvP, Sirks, was never mentioned as a possible candidate. M.J. Sirks (1889-1966) was appointed at the Institute for Plant Breeding in 1917. He had a doctorate, was one of the leading geneticists in the Netherlands and certainly comparable with Honing in terms of scientific background

[47] Ibid.

[48] Stamhuis, "A Female contribution to Early Genetics."

[49] *Archive Lh,* 2415.

[50] Groenewolt, "In memoriam Prof. Ir. C. Broekema."

[51] *Archive Lh,* 2416.

and research experience.[52] The only difference between the two was that Sirks never had a leading management position in the institutes he worked at.

The new professor in plant breeding and director of the IvP presented his plans in his inaugural lecture. He presented the findings acquired during the requested initial study leave and his main conclusion was that "the magnificent development of genetics has aligned plant breeding too much to Mendelism."[53] Broekema was less interested in segregation ratios of plant characters as in the connection between physiological characteristics and genetic composition of plants. Such research should lead to more insight in the process of combining favourable characters of parental plants in the offspring, the main objective of plant breeders. "The Institute thus will do its share to supplement our superficial judgement with clear distinction and to enable breeders to follow exact physiological research, more then until now has been the case. (...) What the institute can do is to strengthen the fundamentals on which plant breeding has to rest."[54] With his research programme Broekema tried to support plant breeding with biological causalities, although he warned his audience that direct results from such research would not be available in the short run. "The number of unknown variables to work with is still the majority. Therefore, the practical view, patience and the fortuitous hand of the breeder will continue to dominate plant breeding for long. There is no way we can yet consider breeding as applied genetics."[55] How Broekema worked out his plans he set out in the inaugural speech will be discussed in the following section. First his plans will be compared with the plans of Honing, the professor who was supposed to lead the Institute for Plant Breeding.

In his inaugural lecture Honing discussed genetics in relation to evolution. He presented various theories about the basic principles of evolution and he concluded that none of the theories provided a satisfactory answer to the question of evolution. Therefore Honing suggested that "it is better when biologists leave evolutionary theory to the philosophers for a while and concentrate on experimental research".[56] Experimental research was in Honing's view the basis of genetics. He conceived a theory of evolution as the roof of the genetics building and he saw little use in constructing a roof when the foundations were not yet finished. Although the concrete research plans of Honing differed from the research activities envisioned by Broekema, the two inaugural lectures show much unanimity in the kind of work needing to be done, namely experimental research. Of course Broekema held his lecture some years after Honing and considering the overlap in genetics and plant breeding some convergence or overlap in the research plans is not very surprising.

[52] Smit, "Sirks, Marius Jacob." Noordman, *Om de kwaliteit van het nageslacht*.

[53] Broekema, *Plantenveredeling en Wetenschap*, 8.

[54] Ibid., 17; 19.

[55] Ibid., 10.

[56] Honing, *Erfelijkheidsleer zonder evolutietheorieën*, 13.

Moreover, at the end of the 1910s the American biologists Morgan related Mendelian segregation ratios with cytology and experimental embryology, resulting in a revitalised version of chromosome theory.[57] His experiments, for which he used fruit flies (*Drosophila melanogaster*) opened new possibilities for similar research on other species. Although the Wageningen professors showed themselves well-informed about the latest developments in genetics and breeding, the plans they unfolded in the inaugurals must be interpreted in relation to events as such. Inaugural speeches are statements reflecting ideas and desires of professors, but often presented in a form that reveals very little about how plans are to be realised. Moreover, Honing and Broekema were appointed shortly after the Agricultural College was included in the system of higher education. With the acquired academic status professors most likely felt the need to show that they fitted well in an academic environment. Therefore, the question addressed in the next paragraphs is how Broekema realised his plans in relation to the activities of the Institute for Plant Breeding.

**Physiology, cytology and breeding**

Attention to plant physiology in support of plant breeding was not an entirely new subject. The Institute for Plant Breeding in Wageningen already employed several botanists conducting physiological research, mainly on crops that were commonly used in genetic research, like peas.[58] Broekema, however, was not very impressed by the qualities of the IvP staff and requested the board of trustees to have them replaced. Besides competence there were other factors at stake as well. For example, Broekema wanted to replace Sirks, a distinguished geneticist at the time, but apparently not someone who could get along very well with the director of the institute. Most employees of the IvP however had permanent appointments and could not easily be removed.[59] Only some five years after his installation did Broekema carry out the desired replacement of staff. In 1927 a new researcher was appointed, A.E.H.R. Boonstra. His research was supposed to make a connection between plant physiology and plant breeding. What he tried to find out was the hereditary factors of root development, crucial for a plant's capacity to absorb water and minerals and thus its growth potential. Although Boonstra managed to show a correlation between genetic structure, root development and yield, he could not resolve the mechanism behind the interaction. A major uncertainty was the influence of external conditions on plant growth. Despite meagre results Boonstra was convinced that instead of fate thorough research should be the basis of plant

[57] Theunissen en Visser, *De wetten van het leven*, 238.

[58] *Archive Lh*, 2416. De Haan, *Vijftig Jaren*, 33-34.

[59] *Archive Lh*, 1044.

breeding.[60] In 1937 Sirks moved from the IvP to the University of Groningen where he succeeded Tine Tammes as professor in genetics. Sirks' successor was S.J. Wellensiek, repatriated form the Dutch East Indies, where he had worked on the genetics of tea. Wellensiek was less optimistic about the practical importance of physiological research.[61] Nevertheless, experiments in that direction were continued.

A second branch of research conducted at the Institute for Plant Breeding was cytology. In a long letter to the senate Broekema gave an overview of the international literature on plant reproduction that in his view made clear that all aspects of plant breeding relate back to the plant cell.[62] The letter justified the appointment of the cytologists H. Bleier. Bleier worked at the IvP for six years and published frequently about his plant cell research. A central element of his research was the effect of temperature change and radiation on the reproduction process. Extreme temperatures, ultraviolet or X-rays affected the chromosome structure in the germ cells, resulting in artificial mutations. For the radiation experiments the IvP had an agreement with the physics research laboratory of the Philips company in Eindhoven.[63] The mutations caused by extreme temperatures and radiation were considered a possible source for plant improvement, but it appeared difficult to stabilise and multiply such mutants and the work did not result in any useful crop varieties.

In the seventeen years Broekema led the IVP, the biological research conducted at the institute did not deliver the scientific basis of plant breeding as announced in his inaugural lecture. Although the biological research increased the understanding of the hereditary structure of several crops, it could not provide predictions about effects of certain crossings or control plant characteristics by other means. From the beginning Broekema had tempered any expectation of quick results, but in the 1930s he wrote several times to the senate that he preferred to split up the experimental research and the breeding work, appointing for each department a sub-director. His main argument was to create clarity in the tasks of the various employees of the IvP. Broekema did not further specify his argument, but on several occasions he reported conflicts between the research staff and the employees involved in breeding activities.[64] Apparently the connection between biological experimentation and plant breeding not only appeared difficult to establish in the research as such but was also difficult to combine on the level of staff management. Considering his efforts to attract experienced researchers for the physiological and

[60] Boonstra, *Physiologisch onderzoek*.

[61] *Archive Lh*, 1044. Wellensiek, *Grondslagen der Algemeene Plantenveredeling*, 117.

[62] *Archive Lh*, 1044.

[63] Ibid.

[64] Ibid.

cytological experiments, his own activities were entirely concentrated on improvement of agricultural crops and the organisation of the plant breeding sector.

### Regulation and legislation

A major vehicle of the Institute for Plant Breeding in acquiring a special position in the Dutch plant breeding sector was to promote itself as an independent control institute. The first director of the IvP already started with the organisation of the certification of new varieties and inspection of fields for seed multiplication. Crucial was how one variety could be distinguished as new. Pitsch had defined this simply as new seed produced by breeders. Varieties were original when they were different from already known varieties and multiplied seed of certain varieties were inspected on authenticity by the Central Committee for crop inspection. In other words, the certification and inspection system developed in the 1910s followed the supply in varieties offered on the seed market. Broekema reversed that situation and designed new regulations by which he created a central position for the Institute for Plant Breeding. "As the work of the institute will be most effective when performed in close relation with Extension Officers, Inspectors, breeders and other persons and agencies active in the field of plant breeding, research and dispersion of good varieties, I proposed the Directorate of Agriculture to change the regulations of 1914 in such manner that intended cooperation can develop."[65] The proposal was to make a register of the best performing varieties for each crop and only to inspect seed lots of varieties on that list. The regulations for the register were set by Ministerial Decree in October 1924 while the first register already had appeared earlier that year, at the moment farmers started sowing for the coming season.[66] Because the regulation had legal authority, all parties involved in the seed sector had to accept the new regulations. However, the question how compliance with the variety register should be inspected remained unanswered.

As explained above, the Central Committee for crop inspection was an association of several provincial agricultural organisations. Seed companies had established their own inspection service and there was no legal mechanism to force them to use the variety register of the IvP. Broekema and other members of the IvP therefore put much effort in reaching agreement among the parties over the conditions for crop inspection and varieties put on the official register. The negotiations between the agricultural organisations and seed companies took several years and finally in 1932 an agreement was reached, resulting in the creation of the Associated Dutch General Inspection Service (*Vereniging Nederlandse Algemene Keuringsdienst* - NAK). An important reason why the negotiations took so long was because there was no standard defining mechanism related to

[65] *Beschrijvende Rasenlijst.*

[66] *Verslagen en mededeelingen van de Directie van den Landbouw.*

biological features of the different varieties. As the secretary of the Central Committee and employee of the IvP explained in the case of wheat "The control on the authenticity of wheat varieties is in our country almost entirely a control of certificates, and thus a control of paper work. An extensive description of our wheat varieties, enabling judgement in field inspection concerning the authenticity of the varieties has hardly been worked on."[67] In other words, there was no scientific knowledge available to arbitrate different perceptions and stakes in the dispute over a national crop inspection service.

Besides regulating the supply of seed the Institute for Plant Breeding also took the initiative in another issue. Already before Broekema headed the institute, the idea was raised to compensate breeders for their activities by raising a levy on each hectare of multiplied seed. The IvP had a clear interest in arranging this because several varieties released by the institute were widely grown in the Netherlands. For example, L. Broekema, the father of the IvP director, passed on the rights over his wheat varieties to the institute. But similar to the organisation of seed inspection, a clear method or instrument to determine the genetic make-up of a variety was lacking and therefore an arrangement should be made based on conditions accepted by all parties.[68] The first arrangement was made in 1936, implying a compensation for breeders of one and a half guilders for each hectare of reproduced original seed of in-breeding varieties. The multiplication was restricted to 40 hectares per year, in order to prevent large seed companies undercutting smaller ones. Most companies, however, did not agree with the restriction and it was lifted again in 1938. The general principle, a levy on multiplying original seed by which breeders were given an allowance, formed the basis of the official Breeders Decree, (*Kweekersbesluit*) enacted in 1941 and operative from 1942.[69]

The Breeders Decree of 1941 can be considered the finalisation of the regulating and organising activities of the Institute for Plant Breeding. The Breeders Decree regulated the breeder's rights and financial compensation, but also the exchange of seed material in the Netherlands, including the regulations of the Variety Register. The active participation of several members of the IvP, including its director, resulted in a seed system dominated by the government in combination with the institute in Wageningen. Although the senate commission that arranged the appointment of Broekema advised to give up these activities, and despite the attempts of Broekema to create clear division of research and other activities, the Institute for Plant Breeding was characterised by this combination of research and regulation. The IvP was able to maintain both activities because of its close connection with the Directorate of Agriculture. The institute often took the initiative in research and

[67] Koeslag, "De in Nederland in het belang der tarwezaaizaadvoorziening genomen maatregelen."

[68] Addens *Zaaizaad en pootgoed.*

[69] Addens *Zaaizaad en pootgoed*, 188-193. Van der Kooij, *Kwekersrecht in Ontwikkeling.*

regulation, but the agenda of the Dutch government was very important too. An example of the role of the government brings the story back to wheat

One of the laws the Dutch government enacted to reverse the economic decline of the early 1930s was the so-called Wheat Law of 1931. This law stated that flour used for bread baking should be milled from at least 20 (and later even 35 percent) Dutch wheat. With the law the government aimed to decrease the dependence on foreign wheat for the food supply and at the same time support the Dutch wheat farmers. Part of the decision was the creation of a Technical Wheat Commission (*Technische Tarwecommissie*) in which representatives of research institutes, milling companies and bakeries had a seat.[70] The commission had to set out research in order to improve the baking value of the Dutch wheat varieties. Wheat varieties grown in the Netherlands were not very good for baking bread and the varieties with a rather good baking value tended to perform very badly in Dutch conditions. The research programme set out by the commission contained a comparison and analysis of a large number of varieties in different conditions in the Netherlands. The research did not result in a breakthrough. The baking value of Dutch wheat remained very poor and the research was stopped early 1940s.

The example makes clear that research and regulation were not activities clearly divided between the public research institute on the one hand and the Directorate of Agriculture on the other, but always went hand in hand. Ideas and initiatives to set out research or to regulate certain activities could either be taken up by the research institute or the government. As already indicated, for the improvement of agricultural crops and the organisation of the Dutch seed sector, the Breeders Decree of 1941 can be considered as the completion of this double role. Perhaps the director-professor of the Institute for Plant Breeding, C. Broekema, can be considered as the personification of it, although he was hardly active in research. In any case, from 1940, the year Broekema died, the development of genetics and plant breeding implied a new interpretation of the task of the Institute for Plant Breeding.

## Institutional differentiation

During the first half of the twentieth century plant breeding developed as a branch of agricultural science, but also as a branch of agro-industry. The various seed companies produced an increasing number of new varieties and imported foreign varieties, resulting in a growing task in testing these varieties and inspecting its multiplication. The Breeders Decree of 1941 envisioned the creation of a specialised institute for testing varieties and inspecting seed multiplication, the executing body of the decree. In July 1942, the Institute for Variety Research of Cultivated Crops

[70] Van Moorsel, *De Tarwewet 1931, Verslagen van de Technische Tarwecommissie.*

(*Instituut voor Rassenonderzoek van landbouwgewassen* - IVRO) was opened. The first director, J.K. Groenewolt, was a former staff member of the IvP. He estimated that the institute each year had to test about 600 varieties in varying circumstances in the Netherlands for which about 19 test centres of 25 hectare each were needed.[71] The institute tested new varieties of agricultural crops and vegetables. The test results were used to compose the Variety Registers for each year and to determine if breeders received property rights over their varieties.

The disconnection between variety testing and the Institute for Plant Breeding was not the only organisational change. After Broekema's death the senate of the Agricultural College had to look for a new professor-director. The senate proposed one person, the agricultural consultant of the Friesian Society for Agriculture, J.C. Dorst. Dorst graduated in Wageningen and wrote a doctoral thesis on bud mutation of potato, supervised by the Wageningen geneticist Honing. In the discussion about the job offer Dorst made clear to the senate that he wanted to concentrate on "breeding as such".[72] The senate replied that this "could not go so far that the Institute obtains the character of a laboratory."[73] The senate wanted to maintain the direct involvement of the IvP in the breeding sector. "The Institute is because of that splendid propaganda for the college."[74] But after the Second World War the government, financially supported by Marshall aid, enlarged the budget for agricultural research, favouring Dorst's ideas. In consultation with the Dutch breeders association a Foundation for Plant Breeding (*Stichting voor Planten-veredeling* - SVP) was created. This new institute had to support the work of breeders and breeding companies with additional research and crossing experiments that might result in commercial applications in the long run. The Institute for Plant Breeding was supposed to educate students and conduct fundamental research. According to Dorst the main issues to be covered by the research were "generative- and inter-specific crosses, heterosis, artificial mutations, resistance research, physiological and cytological research."[75]

As described in chapter three, putting a research institute into the legal form of a foundation was not exceptional in the 1940s and 1950s. A foundation facilitated involvement of both public and private agencies in setting up experiments and breeding strategies. Although the IvP maintained its name, the institute was in fact transformed into a research laboratory of the Agricultural College. However, the foundation and the institute were housed in the same building and showed much similarity in research activities. The formal independence of the IvP did not imply that the institute disposed of all its contacts with private breeders, seed companies and

[71] *Archive RIVRO*, 65.

[72] *Archive Lh*, 2417.

[73] Ibid.

[74] Ibid.

[75] Ibid.

agricultural organisations. The research of the IvP maintained a clear orientation towards agricultural crops. In sum, the difference between fundamental and applied research, intended with the separation of plant breeding research into an institute and a foundation, was difficult to trace in the description of the research activities of both organisations. But because of the formal independence of the IvP, linkages between science and the breeding sector were primarily dependent on the efforts of the employees of the IvP in that respect. A factor that further enhanced the distance between science and practice was the establishment of new departments at the Agricultural College, involved in issues related to plant improvement and breeding as well.

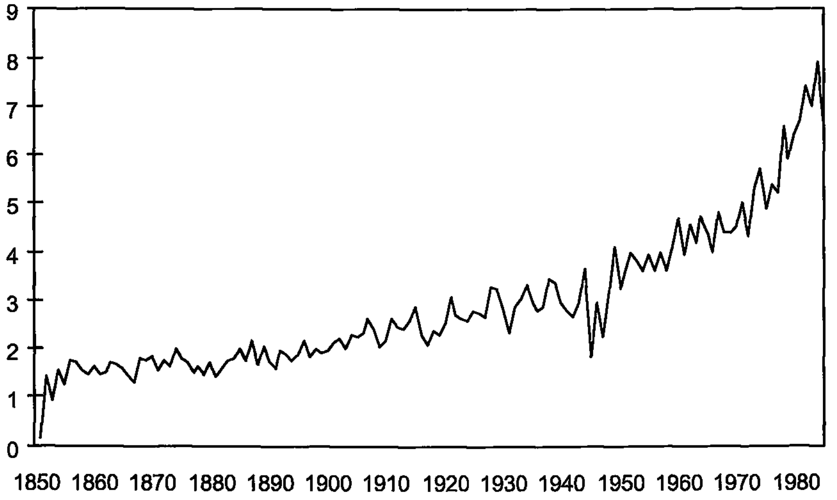
### Research and wheat

The government regulations of the 1930s regarding wheat implied that growers, breeders, seed companies, millers and bakers together decided what reasonable quality standards were for bread wheat, which technical improvements were required and what kind of research should be stimulated. In the case of wheat this cooperation was enforced by law, but in other cases, like barley, growers, breeders and brewers worked together in a similar format. Such arrangements were called 'object associations' and in recent years similar initiatives have been launched in the agrarian sector under the name 'chain management'.[76] After the second World War the wheat law was repealed but in 1950 a new association for wheat and related cereals was established, the Foundation for Co-ordination of Cultivation and Research of Bread Grains, founded in 1950 and after five years renamed as Dutch Grain Centre.[77] The foundation was discontinued in the early 1970s and was in a sense a-typical for its time, because in the 1950s and especially in the 1960s, research related to wheat and other grains dispersed over various research institutes and departments.

[76] Maltha, *Honderd jaar landbouwkundig onderzoek*.

[77] *Jaarboekje van de Stichting voor Coördinatie*.

**Figure 2: Wheat yields, 1850-1985 in metric tons per hectare. (Source: M. Knibbe, *Agriculture in the Netherlands 1851-1950*. CBS.)**




In the 1950s and 1960s a connection was established between genetic research, and physiological and bio-chemical research. The structure of the chromosomes, the carriers of the genetic information of organisms, was unravelled and modelled as strings of deoxyribonucleic acid (DNA). More important than the discovery, as such, was the opening up of new areas of research, making use of all sorts of new techniques. The implication was that genetics became more and more the terrain of biochemists and related experts working on the molecular level. Regarding wheat, more attention was given to composition and structures on the molecular level as well. One of the major conditions for good baking quality of bread wheat was the amount of gluten, a feature already known from the beginning of the twentieth century. Biochemists were able to decompose gluten into albumin, globulin, gliadin and glutenin.[78] In the 1960s a new technique was developed to make the division over the different proteins visible with coloured bands and it became clear that the colour pattern was specific for a variety. The connection between genetics and bio-chemical research created the option to influence the quality of wheat in two ways. One was by intervention in the growth conditions of the plant. Bio-chemical research on wheat made clear that an increase in nitrogen in the plant correlated with an increase in gliadin. This invoked new agronomic research, to find the optimal fertilisation dose, and physiological research, to find an optimal conversion in the grain. The other type of research was to further unravel the genetic code for the various characteristics of wheat. Because bread wheat has 42 chromosomes, each

[78] Boers, *Baktarwe in Nederland*. Gooding and Davies, *Wheat production and utilization.*

with a large number of base-combinations that together encode certain characters, this type of research has not yet resulted in concrete applications in new wheat varieties.[79] Such applications should not only defeat the complexity of the wheat genome, but also overcome the organisational complexity of disciplinary research, field experimentation and application in practice.

As described in chapter three, a major change in the 1950s and 1960s was the disconnection between research performed at the agricultural research institutes and the research of the laboratories or departments of the Agricultural College. The latter were supposed to conduct fundamental research, mainly implying research without formal ties to agricultural practice. Besides this vertical differentiation, research related to genetics and crop improvement was also scattered over various departments. Besides the existing chairs in genetics and plant breeding, statistics became a separate discipline and new chairs were created for biochemistry and molecular biology.[80] The research of each of these departments might have had direct relevance for the improvement of a crop like wheat, but there were no formal mechanisms to realise such a connection or concentrate the research activities of these departments programmes on certain issues in agricultural practice. The Foundation for Plant breeding and the regional experiment stations had much clearer ties with the seed sector, coordinated by the Ministry of Agriculture. To what extent these institutes influenced the improvement of a crop like wheat falls beyond the scope of this study. What can be concluded from figure 2 is that the yield of wheat shows a clear upward trend from the 1950s. Considering the differentiation and dispersion of research activities related to plant genetics, plant breeding and crop growth, its is unclear whether this is because of, or despite, research efforts.

## Conclusion

The connection between science and practice in genetics and plant breeding in the period between the 1870s and the 1970s can be captured in two words: contraction and detachment. During the major part of the nineteenth century plant improvement was a practical activity. Farmers selected out the plants to be used as seed suppliers for the next season, specialised farmer-breeders experimented with plants in various ways to improve agricultural crops and seed traders looked for interesting material in the regions they travelled through or received from others. The selection and crossing techniques became a scientific activity in the Netherlands when teachers of the State Agricultural School included plant

[79] Linko, Javanainen and Linko, "Biotechnology of bread baking."

[80] *Jaarboek Lh.*

breeding in the education and started experimenting at the fields near the school. In the same period plant breeding caught the interest of biologists who, convinced by Darwin's theory of evolution, considered the work of breeders as supportive of insights into natural processes. The cooperation in the 1880s between Martinus Beijerinck, Luitje Broekema and Otto Pitsch at the State Agricultural School in Wageningen makes clear that the interest in plant breeding from a mere theoretical perspective and an interest motivated by improvement of agricultural practice appeared well compatible from the outset. But not every scientist considered that combination desirable, and especially Hugo de Vries, professor in biology at the University of Amsterdam, pleaded for a new institute where a breeding method was employed that favoured his theory of mutation. The wish to create a special institute for plant breeding was also expressed by several agricultural organisations, resulting in the establishment of the IvP in 1912. The creation of this institute implied the formalisation of the connection between plant breeding and genetics as a scientific activity and plant breeding as a practical activity. Phenomena and characteristics of agricultural crops were very conducive for the growth of scientific knowledge of plants and their reproduction, but to make the connection in the other direction appeared far more difficult. Perhaps the only exception was the application of mathematical statistics. Consequently, the Institute for Plant Breeding could not establish a central position in the Dutch breeding sector by generating exclusive knowledge about plant genetics and developing new breeding technologies based on that knowledge. Instead, the institute created testing and inspection procedures that with the help of the government Directorate of Agriculture were made compulsory for breeders and seed traders. In other words, the central position of the Institute for Plant Breeding in the breeding sector was based on the authority of governance rather than on the authority of science. The research activities of the institute were performed parallel to this control function, implying that science and practice were aggregated rather then integrated and already in the 1930s the director of the institute, C. Broekema, proposed to separate the two functions within the organisation of the institute. The moment the Dutch seed sector became fully regulated by the Breeders Decree of 1941, science and practice gradually detached. The legal arrangement of plant breeding implied the creation of a separate institute for testing of new varieties and control of seed multiplication. In the late 1940s the breeding and research activities developed in interaction with the breeding sector were organised in a separate institute, the Foundation for Plant Breeding. The differentiation between the research institute, coordinated by the Ministry of Agriculture, and the research laboratories and departments of the Agricultural College implied a further detachment and dispersion of the connection between science and practice.

The interpretation of a contracting and detaching relation between science and practice results primarily from looking at the organisational aspects of genetics and plant breeding in agricultural science. From the perspective of the exemplar crop used in this chapter, wheat, the resulting picture is that of a gradual integration between science and practice. From the late nineteenth century until roughly the 1920s the main connection between science and wheat was the involvement of scientist-breeders in the improvement of wheat. The breeding work of L. Broekema resulted in a wheat variety, Wilhelmina, that became a major genetic source for Dutch wheat varieties. His breeding work and that of other scientist-breeders of the Wageningen institution was taken over in 1912 by the Institute for Plant Breeding. In the 1930s research in wheat was intensified by law in order to decrease the dependence on import of bread wheat from other countries. The information resulting from this research work was primarily related to features and characteristics of wheat varieties that were visible to the naked eye or measurable with relatively simple instruments. From the late 1950s this type of knowledge was accompanied by information about the various proteins in the grain, important for the processing of wheat into bread or other products as well as for the information about the hereditary features of the different varieties. The information was a result of research efforts in various departments and institutes of agricultural science. The result was a growing amount of information, relevant for crossing and selection of new wheat varieties, used by private breeding companies and research institutes in the Netherlands and other countries. In short, the connection between science and wheat intensified over the years, perhaps tracking the curve of wheat yields as shown in figure 2. This process, however, is not contradictory to the detachment of science and practice in the organisation of genetics and plant breeding. The differentiation in the organisation of agricultural research and the resulting organisational separation of science and practice did not imply that the knowledge generated never reached the wheat fields. The relevance for the improvement of wheat of the scientific research in genetics and related disciplines performed by the departments of the Agricultural College was primarily in terms of the efforts of lower level research institutes, experiment station, breeding firms, seed traders and individual farmers. Wheat yields increased, partly due to science, despite the absence of a well-organised connection between science and practice.

# 6

# Rice breeding in the Dutch colonies

# Introduction

At the end of the nineteenth century the Dutch State inherited military and administrative control over the Dutch East Indies from a bankrupt United East Indies Company. After some initiatives to modernise the colonial administration and develop the colony, the Dutch government fell back on a straightforward exploitation of the resources of the various islands, with no serious interest in the welfare of the Javanese and inhabitants of the other islands. Only in the last decades of the nineteenth century the colonial government started to formulate and implement policies that supported the local population in their livelihood. Crucial in the indigenous economy was the cultivation of rice, by far the major food-crop, and consequently officials of the colonial government created various mechanisms to support this activity. Central in this chapter are the efforts of the colonial government to improve the rice crop by changing the genetic make-up of rice. In other words, the development of plant breeding and genetics is again the subject, but this time in the context of the Dutch colonies. The focus on rice in this chapter is different from the focus on wheat in the previous chapter. In chapter six wheat was mainly an example to illustrate how genetics and plant breeding were included in agricultural science in the Netherlands. Except for the 1930s wheat was not a crop that had the special attention of geneticists and breeders in the major institutes in the Netherlands involved in genetics and plant breeding. Rice, by contrast, was of special interest to the colonial government. The ability to increase and improve the food supply of the local population was more or less the measure of the Netherlands as a responsible and humane coloniser. Moreover, a proper food supply means that the people can spend their time on other activities than arranging a daily meal. And a hungry population is generally not very satisfied and may revolt against its rulers. In other words, besides humanitarian reasons there were also economic and political arguments why the colonial government put much effort into the improvement of food crops. Rice was, and is, not the only crop grown and consumed on Java but it is by far the most important. In result, the public services for agriculture put a great effort into the improvement of rice cultivation. Consequently, public plant breeding and genetics in the colonial context was, for the major part, directly related to rice. Therefore, a constant concern for researchers and officials was how to establish a relation between science and practice. The story follows the activities of various researchers and colonial officials in a chronological order. First the main technical features of the rice crop are briefly discussed, followed by a description of attempts by the colonial administration to improve rice cultivation at the end of the nineteenth century. In the ensuing sections the institutionalisation of research for rice and other food crops at the beginning of the twentieth century is examined. At the end of the 1910s and in the early 1920s the efficacy of rice breeding was questioned and some alternatives were tried out, but at the end of the 1920s rice breeding was firmly established in public agricultural research and extension. The Second World War and the ensuing independence of Indonesia implied a shift from the former colony to a remaining colony, Surinam. Rice breeding was employed there with different objectives and in an entirely different setting. The independence of Surinam in 1975 implied an end to specific and organised breeding programmes in rice by the Dutch. What that implied for Dutch agricultural science is one of the issues addressed in the conclusion.

## Rice breeding on Java

Rice belongs to the genus *Oryza,* comprising twenty-five species distributed through the tropical and subtropical regions of the world. There are only two cultivated species, *O. glaberrima,* confined to West Africa, and *O. sativa.* Rice has been cultivated for several millenia. The Chinese term for rice, for example, is found in inscriptions dating from the second millennium BC. Rice arrived on Java about 1600 BC and the name of the island is said to mean 'Island of Rice'. Although Islam has been the main religion for many centuries, most customs, tales and rituals related to rice are of Hindu origin. In the three main languages of Java (Malay, Javanese and Sundanese) harvested rice stalks are called respectively *padi*, *pari* and *paré*. The Malay term for husked rice is *gabah*, polished rice is called *beras* and boiled rice *nasi*. All cultivated rice on Java is from the species *O. sativa,* but there are numerous different varieties grown on the island.[1] The first serious rice researcher in the Dutch East Indies, J. E. van der Stok, used the classification of the German botanist F. Körnicke.[2] Körnicke was a botany professor at the Agricultural Academy in Poppelsdorf, where Otto Pitsch graduated and Pitsch was one of the teachers of van der Stok. Körnicke divided rice in two groups, *utilissima* and *glutinosa*. The first group is further divided into a *communis* and *minuta* group and most varieties cultivated on Java belong to the *communis* group. Van der Stok, in his turn, distinguished in the *communis* group between *bulu* and *cereh* varieties. There are various distinctions between these two groups of varieties. *Bulu* varieties can be recognised by the awns, where *cereh* varieties are awnless. An important difference is that the *cereh* group is photoperiod sensitive, unlike the *bulu* varieties. Although day-length on Java hardly varies over the seasons, rice was predominantly grown in the wet season when for most of the day clouds obstruct direct sunlight reaching the plant. Under these circumstances awned varieties performed better than awnless varieties. *Cereh* varieties performed relatively well on poorer soils, but with a more rigid stem structure, *bulu* varieties did not lodge on the fertile volcanic soils of the

[1] Grist, *Rice*, 3-7. Paulus, de Graaff en Stibbe, *Encyclopaedie van Nederlands Indië II*, 648.

[2] Körnicke and Werner, *Handbuch des Getreidebaues*.

island.[3] Many activities of Javanese farming communities were adapted to the botanical features of the *bulu* varieties. Grain shattering, for example, is less common among the awned varieties, which allows the farmers to transport and store the rice in bundles on the stalk. *Bulus* had a longer maturation period allowing farmers to stretch the transplantation period, thus allowing more time to get the work done. On Java *Bulu* and *Cereh* varieties were both grown but when conditions were favourable farmers showed a clear preference for *bulus*.[4] Where the *bulu* and *cereh* varieties covered the main area, most farmers had small plots on which varieties of the *glutinosa* group were grown. The distinctive feature of these varieties is the composition of the endosperm. As the name suggests, the grains are sticky and this rice was mostly consumed as a snack or side dish. The taxonomy of rice used in later years is based on a distinction between *Indica* and *Japonica* varieties, followed by one or more additional or sub-groups.[5] The Indonesian *cereh* varieties belong to the *Indica* group, while the *bulus* are considered as a sub-group of *Japonica*, but sometimes considered as a distinct group, called *Javanica* and in table 1 the main characteristics of these groups are listed.

All the literature discussed above, containing detailed descriptions of rice varieties on Java, was published in the twentieth century. Earlier descriptions and statistics about rice are less detailed and provide little information about the various options and activities in exchange and improvement of rice. That does not mean that colonial officials or European researchers from previous centuries were not interested in rice. Since the seventeenth century, when the United East India Company (VOC) firmly settled its trading posts and factories in the Indonesian archipelago, rice was a major concern for the Europeans.[6] Rice was not only the major food crop of the local population, but also of officers, soldiers, administrators, slaves and botanists populating the various settlements. There was, however, no formal linkage between the scientific work of the botanists and the concern for food by the VOC. This linkage was formally made in 1817 with the creation of a Botanic Garden (*'s Lands Plantentuin*) in Buitenzorg, but it took several decades before some plans in rice improvement were developed.

[3] Van der Eng, "Development of Seed-Fertilizer technology." Van der Meulen, "De rijstselectie." Van der Veer, Kuilman en van der Meulen, *De rijstcultuur in Indonesie*. Bernstein, Siwi and Beachell, *The development and diffusion of rice varieties*.

[4] Van der Eng, *Agricultural growth in Indonesia*, 86.

[5] Grist, *Rice*, 101. Barker, Herdt and Rose, *The rice economy of Asia*,16. Chandraratna, *Genetics and breeding of rice*, 5-9.

[6] De Vries, *Rijstpolitiek op Java in vroeger jaren*.

**Table 1: Features of three subspecies of *O. Sativa*. (Source: Barker, Herdt and Rose, *The rice economy of Asia.*)**

| Features | Indica | Japonica | Javanica |
|---|---|---|---|
| Tillering | High | Low | Low |
| Height | Tall | Medium | Tall |
| Lodging | Easily | Not easily | Not easily |
| Photoperiod | Sensitive | Nonsensitive | Nonsensitive |
| Cool temperature | Sensitive | Tolerant | Tolerant |
| Shattering | Easily | Not easily | Not easily |
| Grain Type | Long-to-medium | Short and round | Large and bold |
| Rice texture | Non sticky | Sticky | Intermediate |

### Liberal politics

In 1848 the Dutch state was based on a new constitution, designed by the liberal government of J.R. Thorbecke (1798-1872) and implying a shift in power relations in favour of the parliament and at the expense of the position of the King. A major implication of the constitutional modernisation for the colonies was more openness about the things that were going on the Dutch East Indies and other colonial territories, and the major element in the colonial system attacked by the liberals was the Culture System (*Cultuurstelsel*). The system forced Javanese farmers to cultivate crops that could be sold on the European market, like coffee, indigo and sugar. In the eyes of the liberals the system was a disguised form of slavery, resembling a feudal rather than a modern liberal state. Moreover, the *Cultuurstelsel* was a political target because the King allegedly used the money generated by the system to finance all sorts of projects without consulting representatives. The more conservative politicians valued the financial benefits higher than the humanitarian consequences and the legitimacy of the colonial administration, and it took until 1870 before the Culture System was finally abolished. An idealistic liberal view trying to push the Javanese people in the same direction as the European nations dominated the colonial politics throughout the second half of the nineteenth century, although the conservatives with a pragmatic eye on the income generated by the colonial exploitation were certainly not silenced.[7] The political changes of the late nineteenth century had some clear effects on the food policy in the Dutch East Indies and, consequently, on the attention to rice cultivation.

[7] Aarts, *De letterheren*, 433.

In 1864, the Inspector for Agriculture, H.A. van der Poel, wrote a manual to be used by the colonial administrators in order to stimulate rice production.[8] Van der Poel made a direct connection between the Culture System and the deplorable state of rice farming. He argued that farmers should be reminded of the activities and elements they had neglected for years, because they had to spend all their time on the growth of crops prescribed by the colonial administration. The main things that needed more attention according to van der Poel were selection and storage of seed and activities regarding water management, transplanting and harvest. Van der Poel's manual reflected the liberal criticism of the Culture System and stressed that the administration should act more responsible towards its subjects. Nevertheless, the interest in rice cultivation had a clear financial element. Declining revenues from the Culture System invoked a renewed interest in the taxation system in the colonies, the so-called land-rent (*landrente*), a levy based on cultivated area and yield. The taxation was introduced at the beginning of the century, and never functioned very well, but because the Culture System was much more effective in that respect the colonial government gave a well-functioning land-rent system less priority.[9] The major problem to be tackled was perhaps less actual improvement in rice yield, as improvement in the estimations of the colonial administrators as to what the yield was. The officials generally had little idea what exactly was produced by the farmers, partly because they lacked proper methods to assess this, partly because they had only very little training and experience in agriculture. Although in 1876 an agricultural school was attached to the Botanical Garden, it was closed again in 1882 because newly-arriving colonial civil servants who were supposed to attend the classes hardly showed up.[10] In other words, the colonial administration was not the best vehicle to introduce and disperse agricultural improvements, something acknowledged by van der Poel's successor, J.H.F. Sollewijn Gelpke. For him the only way to improve agriculture was to release that duty from "the overloaded servants of the colonial administration and consign it to a corps of special servants".[11] Moreover, he pointed out that there was no institute or mechanism by which knowledge about Javanese rice farming was generated. In his view the Botanic Garden was not very well suited for it and therefore a new experiment station should be created. "The station must be the scientific centre for rice culture in the residencies."[12]

The document of Sollewijn Gelpke is a clear example of the liberal perception of colonial rule. He made an analysis of rice cultivation in Italy and Java, and for him it was clear that the rational way the Italians grew their rice stood in sharp contrast

[8] Van der Poel, "Nota over de rijstkultuur."

[9] See chapter 7.

[10] Van den Doel, *De stille macht*, 221. Fasseur, *De Indologen*, 132.

[11] Sollewijn Gelpke, *De rijstcultuur in Italië en op Java*, 111.

[12] Ibid., 192.

to the situation on Java where rice cultivation was "in a miserable situation because of the enormous waste of energy and the almost insane superstition with which it is performed."[13] Some more details of his comparison are worth mentioning. According to Sollewijn Gelpke the Javanese farmers determined the time for transplanting with "cabalistic calculations" where the Italian rice farmer relates it to the climate. Lacking irrigation water the Javanese farmer waited for rain, and when the rains did not come, he reverted to sorcery. The Italian rice farmer only starts growing rice when he has assured himself of acquiring water.[14] The study of Sollewijn Gelpke on Javanese and Italian rice farming, for which he received a doctorate from Leiden University, must not be interpreted as a comparison to balance advantages and disadvantages of the two systems but as a rhetorical device to make clear that a Western model was urgently needed. Despite all the rhetoric, the points Sollewijn Gelpke made about the incompetence of the colonial administration regarding agriculture and the lack of knowledge about Javanese rice farming were picked up by the colonial government at the beginning of the twentieth century.

### The Botanic Garden and agriculture

It is unclear why Sollwijn Gelpke considered the Botanic Garden (*'s Lands Plantentuin*) as not very suited for research on rice. He probably considered rice research so important that a special institute should be raised for it. Some disappointment about what the Botanic Garden had done for rice so far might have been an additional reason. In any case, some years after he published his report, research activities in the Botanic Garden moved in a different direction, with direct consequences for agricultural research and, somewhat later, for rice research as well. Since its origin in 1817 one of the objectives of the Botanic Garden was the improvement of agriculture. The major activities in that respect were the collection of species of agricultural crops, primarily perennial crops, some chemical research on the composition of useful substances, like (for example) quinine from the cinchona tree, and agronomic experiments with planting distances, combinations of crops, fertilisation and so on. The main orientation, however, was on the natural order of the various species and subspecies. The international network of botanists and botanical gardens provided useful information about plant types with the best features for agricultural purposes. Expeditions, either formally arranged or secretly planned, and friendly relations between the different botanical gardens brought in new plant material and information. In the 1850s some activity was employed in collecting rice samples from various regions of Java, but according to the researcher responsible, K.W.

[13] Ibid., 111.

[14] Ibid., 183-188.

van Gorkom, they were not able to determine if features were type-specific or a result of the varying growth conditions. "Under such circumstances and for these reasons, a serious pursuit for an exact botanical determination appears to us as highly difficult and more of scientific than of practical value."[15] The major activity regarding rice was testing varieties received from other countries. The Botanic Garden was not formally involved in the attempts of the colonial administration in the 1860s and 1870s to improve rice cultivation.

The research performed at the Botanic Garden got a new dimension in 1880. In that year Melchior Treub (1851-1910) became the new director of the garden and related facilities. Treub was a representative of a generation of Dutch botanists that had taken up Darwin's evolution theory. According to this theory the variation in species should not be considered as aberrations of (in principle) stable species, but the driving force of change and species formation in nature. Darwin's theory raised a whole series of new questions and consequently opened new paths in biological research, primarily in genetics, physiology and plant-environment interaction. Treub actively promoted this new approach by creating research facilities and inviting botanists from all over the world to study nature in Java, for which he built a special 'strangers laboratory' at the Botanic Garden.[16] The new research approach in botany also implied a changed relation with agriculture. Agriculture was not just a field where new species and varieties were introduced, but also a field for biological research. Selecting certain plants for seed material, influencing growth conditions with pest control, fertilisation and the like was considered a cultural mirror image of the process of evolution. In other words, agriculture became an interesting study object for biologists. Treub was the right kind of person to explore the possibilities of agriculture in a very fruitful way. Moreover, the agricultural crisis of the 1880s gave plantation owners the incentive to invest in agricultural research in the hope that crop improvement and control of diseases could be realised in the short term. Plantation owners organised and several of these organisations set up research station themselves. Others paid for research conducted by Treub and his staff at the Botanic Garden.

Treub's successful efforts to combine the money of the planters with the knowledge of botanists, chemists and other scientists had no direct spin-off to indigenous rice production. In the late 1890s the colonial administration assigned to him the organisation of so-called demonstration fields. Previously, such fields had been set up by K.F. Holle, a former tea planter who was knowledgeable about indigenous rice cultivation and advised the colonial government on improvements to be introduced by administrators.[17] Both administrators and farmers could go and see in these fields how rice should be grown. In 1899 Treub set up four

[15] Van Gorkom, *De Oost-Indische cultures*, 139

[16] Cittadino, *Nature as the laboratory*, 76-79. Zeijlstra, *Melchior Treub*.

[17] Van den Doel, *De stille macht*, 220.

demonstration fields close to a major village in different parts of Java.[18] But already a year later the colonial government came with a new request to Treub, this time for a much more extensive plan.

### Research policy

Treub was assigned by the colonial government to design a new department of the colonial administration, a Department of Agriculture. In 1902 Treub published his 'Schematic note on the formation of an agricultural department'. The plan was perhaps schematic on the details of the nascent department but certainly not on its character. Treub spent many pages explaining that such a department would only function well when it was not an administrative body but a centre for agricultural research. Consequently, rice cultivation should be further stimulated by research and Treub proposed three major research themes. First was research on the rice plant from sowing to storage of the harvest. "The demands and peculiarities of the different paddy species and varieties have to be checked on these points. This research is combined with local expert judgement in different parts of Java regarding soil and climatic conditions."[19] The second research theme was causes and transmission of diseases in rice and options for pest control. The third theme was soil research to determine the options to increase the area grown with rice. The demonstration fields were continued and increased in number.

In 1905 the Department of Agriculture became effective, and the director was Treub himself. Treub's proposal was effected without major modifications. The research on rice and other food crops was put under a division called Experiment Station for Rice and Secondary Crops (*Proefstation voor Rijst en Tweede Gewassen*).[20] For each of the research themes a researcher was appointed, and for the variety research this was J.P. Moquette, recruited from one of the experiment stations for sugarcane. Moquette started with an inventory of the existing varieties on Java. In a short period of time he received 6400 samples that he sorted into 751 *communis* and 141 *glutinosa* varieties from which he planted respectively 594 and 114 in November 1905. There is only one publication of Moquette about his work on rice, presenting the work of one year in which his main finding was from occasional crosses between the *communis* and *glutinosa* varieties, concluding that the first should be considered as dominant over the second.[21] Moquette had to leave his post because of illness and in July 1906 his position was taken over by J.E. van der Stok.[22] Johan Ewald van der Stok was

[18] Treub, "Demonstratievelden voor Inlandsche cultures."

[19] Treub, *Schematische nota*, 13.

[20] Idenburg, "Memorie van Toelichting", 405.

[21] Moquette, "Voorlopog verslag over het vinden van rijstkorrels." Van der Meulen, "De rijstselectie", 3.

[22] *Jaarboek van het Department van Landbouw* (1906), 134.

born in Buitenzorg in 1880. He went to secondary school in Amsterdam and studied at the State Agricultural School in Wageningen. In 1903 he returned to Java, where he became research assistant at the sugar research station at Pasuruan. At the Experiment Station for Rice and Secondary Crops he continued the research of Moquette. In the period he sought out the hereditary features of various rice varieties the director of the Department of Agriculture was involved in a discussion about the direction he was taking.

In the first years of the twentieth century the welfare of the indigenous population of the Dutch East Indies was officially declared as the spearhead of colonial politics. All sorts of initiatives were employed, among others an extensive research into the economic situation of the local people. The leader of this research, H.E. Steimetz, had serious criticisms of the functioning of the demonstration fields of Treub's department. His main objection concerned the supervision of the fields, a task Treub had given to indigenous civil servants, the so-called *mantri.* These *mantri* belonged to the local elite, and because of their status hardly interfered with the mundane activities of rice farmers.[23] The Inspector of Agriculture and subordinate of Treub, van Breda de Haan, expressed the same view to the Minister of Colonies while on leave in the Netherlands. Instead of young aristocrats van Breda de Haan proposed to put in charge any Javanese interested in agriculture with a certificate of the agricultural school in Buitenzorg, supervised by a European agronomist.[24] The colonial government took up the advice of van Breda de Haan and asked Treub to implement the plan. Treub agreed (reluctantly) but at the same time tried to push the discussion in another direction, the direction of more research. "Three conclusions that can be drawn from contemporary studies and examinations with specific significance for practice are; 1) there is a bigger chance than expected that improved varieties will be found soon; 2) the limitations of selection can be assessed better; 3) the consequences of crosses can often be predicted with mathematical precision."[25] To implement the research Treub proposed to create a selection garden and a model rice farm. The idea for a selection garden was approved but the rice farm was rejected, based on advice the colonial government sought from the Director-General of agriculture in the Netherlands, H.J. Lovink. In the same year these issues were at stake Treub became ill and resigned from his position and was replaced by Lovink. Lovink immediately started to implement the plans proposed by van Breda de Haan.

The arrival of Lovink at the Department of Agriculture in 1909 implied that the improvement of indigenous agriculture would be organised in a different way. The major focus of Lovink was the concept of information exchange between experts

[23] Van den Doel, *De stille macht*, 231.

[24] Ibid., 229.

[25] Creutzberg, *Het economisch beleid, eerste stuk*, 347-348.

employed by the Department of Agriculture and local farmers , for which he created an Extension Service in 1912. The demonstration fields in Treub's concept were principally an exhibition ground where administrators and farmers could take a look whenever they felt like. For Lovink such fields were not just shop-windows for innovations but mechanisms to receive information about local farming, conditions, bottlenecks and possible improvements. The fields still were sources of information, but primarily for the agricultural experts of the Extension Service who translated and dispersed the information to farmers in various ways.[26] Lovink increased the number of fields, but also moved them from central localities near a larger village to more remote places in the midst of agricultural activity - many people passing by was less important than the information generated by these fields. In short, Lovink changed the passive extension mechanism of Treub into an active extension mechanism. The Extension Service employed a number of Wageningen-trained agronomists (12 in the first year) heading a jurisdiction assisted by several indigenous agronomists. These indigenous agronomists were graduates of the newly created agricultural school in Buitenzorg. The changes in the organisation of the Department of Agriculture had considerable consequences for the research activities of van der Stok.

### Breeding programmes

The reorganisation of the Department of Agriculture included a new division of the activities for rice improvement. The Experiment Station for Rice and Second Crops continued with its research on plant physiology and diseases of rice and other food crops. The breeding activities of the station, including the Selection and Seed Garden created by Treub, became part of the Extension Service. Besides the Selection and Seed Garden in Buitenzorg, three more such gardens were laid out in different parts of Java. In the first annual report of the Extension Service, van der Stok, head of the Selection and Seed Gardens for rice and other annual crops, described the activities and objectives of the gardens; "a) breeding of new and improvement of existing varieties; b) comparing varieties in field tests; c) maintaining, multiplying and controlling improved varieties; d) supplying seed material; e) acknowledgement, control and maintenance of improved varieties by third parties; f) stimulating approved seed material."[27] These activities were rather different from the kind of work van der Stok had done previously.

In his first period at the Research Station for Rice and Second Crops van der Stok spent most of his time studying the reproduction and growth processes in different varieties of rice and other crops like cassava, groundnut and sweet potato. In 1910 he left the Department and returned to the Pasuruan sugar

[26] Perk, *Historische ontwikkeling van de landbouwvoorlichting.*

[27] *Jaarverslag van de Landbouwvoorlichtingsdienst* (1912).

research station for two years, but not after compiling his research findings, one of the earliest monographs on rice in the tropics. The book gives a detailed account of the flowering of rice, resulting in the discovery that rice was self-pollinating and not cross-pollinating, as was generally thought at the time. He measured length, weight, density and other features of different rice varieties and tried to figure out which features were hereditary and what the segregation ratios were. Moreover, he managed to make artificial crossed between different varieties. Although van der Stok probably did all his experiment on the terrain of the Botanic Garden, he was well aware of the overall objective of his work, practical results. In that light he considered artificial crossing of rice as a not very profitable venture. "One can see how complicated the segregation of rice crossings can be. As a consequence of this complicated inheritance structure, crossing will be very problematic and lead to major disappointments regarding practical results."[28] What remained was applying selection. In 1907 he published his view on the principles of selection in relation to cereal crops, discussing the work of the leading geneticists in the world. Van der Stok argued along the lines of the Danish geneticist Johannsen who made a distinction between morphological and physiological differences. Based on this difference Johannsen coined the term 'pure line' or pedigree culture. A pure line (pedigree) is based on physiological differences within a single morphological type, where the physiological entities have a stable quantitative variation. Following the difference between morphological and physiological features he distinguished two types of selection. One is selection of types with the "experienced, naked eye" and the other is based on distinctions that can only be measured with instruments, such as density or distribution of grain weight in the ear.[29] For van der Stok only the second method was a real plant breeding method and, based on such measurements, selection over several generations should lead to a differentiation of different lines. This latter element was needed to prevent regression, the decline of outstanding features into the average of the population after several generations. Van der Stok refuted the idea of Hugo de Vries that only single selection was needed to create new types.[30] The consequences of van der Stok's theoretical position is a selection programme that needed detailed measurement of the plants over several seasons. But when he returned to the Department of Agriculture and became head of the Selection and Seed Gardens, the new course set out by Lovink implied that the track from research to practical results had to be shortened.

Van der Stok's ideas about selection from 1912 did not deviate from the position he took in 1907. "Once it is decided with a comparative variety test, which of the landraces grown by the local farmers has performed best, then the practical value

[28] Van der Stok, *Onderzoekingen omtrent rijst en tweede gewassen* (1910), 94.

[29] Van der Stok, "Veredeling van zaaizaad voor een- of tweejarige gewassen."

[30] Ibid.

of these varieties can be increased by applying the breeding method of division into pure lines."[31] Van der Stok realised that such a programme would need many years before direct results were obtained. "For that purpose it is necessary that well-organised comparative variety tests are set up, rationally distributed over the whole area to be covered, and lasting several years, before reliable conclusions can be drawn from the results."[32] As a compromise he allowed the extension officers to disperse seed material after a first selection. "We were able to do so, because the varieties, of which seed has been provided, are primarily local varieties, of which the indigenous farmer generally by experience knows quite well under what conditions they will perform best."[33] The 'well-organised comparative variety tests' not only required a long breath, but also qualified and experienced breeders. Although all extension officers were trained in agronomy, it is doubtful whether they could perform the breeding programmes envisioned by van der Stok. As a result, the Selection and Seed Gardens outside Buitenzorg merely functioned as test and distribution centres for improved varieties. The more extensive selection work was performed at the garden in Buitenzorg, being "the scientific institute where various issues are investigated regarding selection of annual crops, especially concerning the methods of selection. (...) The garden will be, put technically, for different species, a store of genes."[34] The breeding programme for rice was in fact a combination of two methods, a pure-line method, theoretically underpinned by van der Stok in his 1907 publication, and the selection of line-mixtures, performed by the extension officers in the different regions. In the second half of the 1910s, one of van der Stok's assistants (and later his successor), Koch, set up a series of experiments to compare the two approaches.

Louis Koch was born in Surabaya in 1890 and after secondary school he went to the Agricultural School in Wageningen where he graduated in 1912. The same year he returned to Java and joined the Extension Service, added to the staff of the selection garden in Buitenzorg. In 1917 he replaced van der Stok, who became Inspector of Agriculture, a position later transformed into head of the Agricultural Division of the Department of Agriculture and occupied by him until appointed as professor in Colonial Agriculture at the Agricultural College in Wageningen in 1925. In 1916 Koch started a series of experiments to test the method that "has become well known by the publications of the breeding station in Svalöf (Sweden) and that, almost unmodified, is applied in many countries. (...) This method is apparently considered as so evident, that in the literature on selection one will search in vain for any critical empirical research on the

[31] *Jaarverslag van de Landbouwvoorlichtingsdienst* (1912).

[32] *Verslag van de vergadering van ambtenaren*, 14.

[33] Ibid.

[34] Ibid., 17.

correctness of this position."[35] In the experiments the performance of pure lines was compared with that of a mixture of different lines of rice, resulting from mass-selections. The results were clear. Only in a few cases pure lines out-yielded the mixtures and after three years the research concluded that "in practice pure line selection for the paddy crop provides too little guarantees of success."[36] In a bit more than ten years the conviction that pure line selection was the best method changed into a compromise, with selection of line mixtures, and a contested pure line method. Arguments for and against the pure line method were already noted by van der Stok and confirmed by Koch's experiments. Where van der Stok was given ample space by Treub to pursue a solid, albeit time-consuming method, under Lovink the breeding programme was directed towards more interaction with farming practice, resulting in a preference for working with line mixtures. The call for direct practical results at the time Koch headed the breeding station, however, came during a tumultuous period. The food situation on Java was precarious. The island was not self-supporting and shipping of rice became nearly impossible because international waters were full of mines and submarines. Moreover, in the 1918-1919 monsoon season, a drought struck the whole region of South East Asia and all countries in the region closed their borders for food exports. The colonial government desperately tried to prevent famines and searched for solutions with short term results. Activities in rice breeding were stopped for three years.

### Experiments in mechanised farming

The appointment of Lovink as head of the Department of Agriculture implied more exchange between science and practice but also more exchange between the colonial administration and food production. Because Java was a net importer of rice, the Department of Agriculture had to buy rice from other countries in the region, for which estimates of the required purchases were very important. Moreover, the imported rice had to be distributed to the most distressed areas. For that reason assembling information about the local food economy became one of the activities of the Extension Service set up by Lovink. These economic activities directly interfered with the technical problems researchers like van der Stok and Koch tried to tackle. In order to understand the connection between economic policy, research and local food production, two developments will be further examined.

One of the strategies to diminish rice imports and reduce the risk of famines was to broaden the diet of the Javanese people. A crop that emerged as a very important food crop in the 1910s was cassava. Introduced on Java probably in the early 1800s it covered only about 2% of the cultivated area in 1880 but climbed

[35] *Jaarverslag van de Landbouwvoorlichtingsdienst* (1916), 346.

[36] Koch, "Uitkomsten van eenige selectieproeven met padi."

into the top three food crops in the first two decades of the twentieth century. The increase of cassava production in this period was a result of a range of factors. The opportunities for export increased after tapioca manufacturing expanded considerably late 1890s, although even at its peak in the 1920s cassava exports only covered fifteen percent of the total production. The other eighty-five percent was used for consumption and the growing popularity of cassava was probably caused by two favourable characteristics of the crop. One is its tolerance of dry and adverse soil conditions, making the crop a good alternative in dry years. The other is the extended period of harvesting. From the moment a cassava plant reached a certain size, its tubers could be dug up when needed. The inclusion of cassava in the diet of the Javanese was more or less a self-emerging process. In the 1910s the government stimulated cassava consumption with various measures, but at a moment when cassava production already had increased considerably.[37] The attention to cassava also affected the activities of the researchers in Buitenzorg. The policy to focus on alternatives to rice in combination with the difficulties in finding a proper rice breeding method resulted in more attention to crops like cassava. Where van der Stok's main work was on rice, Koch spent much time in cassava improvement and wrote down his experiences with cassava breeding after he repatriated in the early 1930s. He received a doctorate for the work, under supervision of his former boss, van der Stok.[38] The focus on alternative food crops and the break in rice breeding, however, did not imply that rice improvement was no longer an issues.

The acute rice shortages in the years after the first World War induced the start of a new experiment in rice production, guided by a new director of the Department of Agriculture, J. Sibinga Mulder (1866-1944). Sibinga Mulder was one of the first graduates of the Agricultural School in Wageningen. In 1887 he left for the East Indies and worked primarily on sugar plantations. Before he succeeded Lovink in 1918 he had fulfilled several missions for the Dutch government to develop agriculture in Surinam.[39] In January 1919 he proposed to the Governor-General of the East Indies to start an experiment with mechanised rice farming on Sumatra. He was informed that a company in California, USA, had successfully applied this method. "Sowing in wet soil without transplanting is now technically possible and the company is very profitable even with normal (pre-war) prices (...)."[40] If the experiment succeeded the only thing the government would have to do is "to urge the spirit of capitalist agricultural enterprises to pick it up and to provide them with the necessary land and water concessions without the usual

[37] Boomgaard and van Zanden, "Food crops and arable lands", 43. Van der Eng, *Agricultural growth in Indonesia*, 200.

[38] Koch, *Cassaveselectie*.

[39] Docters van Leeuwen, "J. Sibinga Mulder, 1866-1944."

[40] Creutzberg, *Het economisch beleid, tweede stuk*, 246.

formalities."[41] Preparations and first activities already started in July of the same year. A flat area near the river Selatdjaran on Sumatra was selected for the experiment. In May 1920 a dike stretching over 11 km was finished, embracing about 700 hectares of land. Much delay was caused by problems with the water management and the clearing of the land. In March 1921 50 hectares were sown with rice. A lack of water and an abundance of rats made the engineers decide to plough the crop before maturation and to sow the plot anew, adding another 70 hectares.[42] Rats this time were accompanied by the Walang Sangit bug (*Leptocorisa acuta* Thunb.), which destroyed most of the crop. In 1923 the area still had not a harvest and it was decided to stop the experiment after the 1923-1924 season. The total costs were estimated at 1.3 million guilders and Sibinga Mulder was removed from office.[43] In the same year rice breeding was taken up again.

The emergence of cassava as an alternative food crop, and the mechanised rice farming experiment, have in common that a linkage was made between administrative measures, research, technical support and farming activities. In the case of cassava, however, it is questionable to what extent the administrative and technical efforts affected the rise to prominence of the crop in the consumption patterns of the Javanese. The failed experiment in mechanised rice farming makes clear that rice cultivation in the humid tropics is not an activity that is easy to expand to a larger scale. In other words, the best thing the colonial government could do was to zero in on ongoing developments in indigenous food production, providing inputs and organising conditions favourable for the Javanese farmers. For crops like cassava and rice this mainly implied the introduction of varieties with higher yields.

### Seed distribution

In 1923 breeding activities for rice were picked up again. Although Koch had demonstrated that pure lines yielded less than variety mixtures, he applied both methods, mainly because in the 1920s some line selections imported from other regions appeared to perform relatively well. Besides the breeding activities Koch focused the activities on another element, the distribution of improved rice seed. Seed distribution was not an entirely new problem for the Department of Agriculture. In 1915 van der Stok had presented two models. One was to pick out some farmers and pay them for multiplication of seed. The harvested rice is then bought by the government and distributed among farmers. The other option was to supply farmers with improved seed material and leave the distribution to the

[41] Ibid., 248.

[42] *Jaarverslag van de Landbouwvoorlichtingsdienst* (1920-1921), 53-57.

[43] Creutzberg, *Het economisch beleid, tweede stuk*, 374.

farmers themselves. Neither of the two methods was seen as ideal and van der Stok concluded that depending on the situation one has to opt for the best solution.[44] In other words, seed distribution was to be left to the insight of the agricultural extension officers. The issue came back onto the agenda in the late 1920s. In that period the various divisions and laboratories for indigenous agriculture were reorganised with the idea to make them more effective.[45] Moreover, the extension service was looking for a new balance in its activities, since one of its major targets, introduction of chemical fertiliser, had disappointing results. It appeared that the Javanese farmer was not interested in buying a rather costly input, and therefore more attention could be given to the introduction and dispersion of improved rice varieties.[46] More generally, the extension service had reached a size favouring a more active involvement in seed distribution. In 1912 the Service started with 11 (Dutch) consultants, 9 adjunct-consultants (7 Dutch, 2 Javanese) and 28 indigenous consultants. In 1930 there were 19 first class consultants, 34 consultants, 12 agricultural civil servants and 104 assistant consultants. Although some Javanese had been raised to the office of agricultural consultant, 'assistant' and 'indigenous' were pretty much the same categories.[47]

In 1928 Koch justified the new emphasis on seed distribution in the main agricultural journal in the Dutch East Indies. He gave a sketch of seed distribution in Japan, British India and the Dutch East Indies and without clear figures concluded that "in other countries the distribution is effectuated very systematically where here a definite system is either lacking or not applied consistently."[48] Released varieties hardly spread because most of the seed material was used for consumption or mixed with local varieties, undoing the advantage of the releases. For Koch one of the major deficiencies in the Dutch East Indies was the small size of farms. "Were there larger farms, then the situation would look quite different".[49] Koch implied that large farmers would have better opportunities to reserve part of the fields for multiplication of seed and in the absence of such larger farms the government should take up multiplication. The idea was to create so-called Soil-type Selection Gardens, (*Bodemtype-selectietuinen*) and between 1928 and 1938 six such gardens were established. The breeding station in Buitenzorg was the central place where the initial selection of varieties took place. Promising varieties were tested in the Soil-type Selection Gardens and depending on their performance they were released in areas with similar soil conditions. The

[44] Lovink, "Beknopt verslag van het verhandelde."

[45] See chapter 3.

[46] Van der Eng, *Agricultural growth in Indonesia*, 108-114.

[47] *Jaarverslag van de Landbouwvoorlichtingsdienst.* Regeeringsalmanak van NI.

[48] Koch, "Over het verkrijgen van verbeterde variëteiten", 284.

[49] Ibid., 285.

increased efforts in the testing and distribution of new rice varieties created a new problem.

The Extension Service had various methods to introduce and distribute innovations, ranging from direct on-farm display to radio broadcasting.[50] As the introductions were based on voluntary participation some farmers adopted proposed innovations, others did not. Exactly that random element was problematic in the dispersion of improved varieties because improved and traditional varieties on neighbouring fields could easily lead to a loss of advantageous characteristics through random cross-pollination or mixing of seed material. The best way to prevent that was to cover a large connected area with improved seed. Mere promotion activities were too noncommittal to guarantee such an effect and a solution was sought in the creation seed farms where large amounts of seed were produced and distributed to all farmers in the region. The seed farms were funded by the colonial government and provided rice farmers with cheap seed. But that appeared insufficient. One of the extension officers, J.H.L. Joosten, explained in an article about the issue that the relatively prosperous yields and the enormous number of rice farmers in the region he worked, North-West Java, made it difficult to supply all farmers with improved seed material. "It therefore became necessary to put between the Extension Service and the farmers a number of nursery farmers to realise the final mass multiplication; these persons were given the name 'bibit-growers'.[51] *Bibit* is the Malay word for young plant material and the number of *bibit* growers in the area increased from 9 in 1933 to 123 in 1938, each growing 1 hectare of improved seed. The *bibit* growers were contract farmers who had to sell the entire yield to central government-run distribution centres, from where it was supplied to farmers on a credit base. Critical in this system, according to Joosten, were the number of *bibit* growers and the number of buildings for seed storage. He calculated that with the equipment of the time one third of the rice fields in his area could be supplied with improved seed.[52] The bottleneck pointed out by Joosten, insufficient facilities for large scale multiplication and distribution, appeared to be limiting in other areas as well.[53]

[50] Perk, *Historische ontwikkeling van de landbouwvoorlichting.*

[51] Joosten, "Zaaizaadvoorziening voor rijst", 748.

[52] Ibid., 751.

[53] Ten Hove, "De vermeerdering en de verspreiding."

**Table 2: Rice varieties released by the Department of Agriculture. (Source: Landbouwkundig Instituut, *Beschrijvende lijst*.)**

| Variety | Origin | Selection method |
|---|---|---|
| Andel sijem | Modjokerto | Purified population |
| Baiang | British India | Population |
| Bali kambang | Plitar | Pure line |
| Bandang poetih | Padang | Purified population |
| Baok | Tjiandoer | Pure line |
| Beak ganggas | Lombok | Purified population |
| Brondol Poetih 277 | Bantam | Pure line |
| Brondol poetih T43 | Bantam | Pure line |
| Chingfow | British India (Assam) | Population |
| Djalen | Krawang | Pure line |
| Emata | British india (Burma) | Population |
| Gedangan | Modjokerto | Pure line |
| Gendjah beton | Adikarta | Purified population |
| Gendjah ratji | Pasoeroean | Purified population |
| Kerang Sernag (Carolina) | Tangerang | Pure line |
| Ketan gadjih | Kedoeng Banteng (Tegal) | Purified population |
| Ketan Serang | Demak | Purified population |
| Lati sail (Assam) | British India (Assam) | Pure line |
| Loesi | British India | Pure line |
| Major | Cheribon | Purified population |
| Naga dhau | British India (Manipar, Assam) | Population |
| Oentoeng | British India (Bengal) | Pure line |
| Oerang-oerangan | Blitar | Pure line |
| Pandan | Koeningan | Pure line |
| Rogol | Buitenzorg | Pure line |
| Sijem modo | Modjokerto | Purified population |
| Skrivimankoti | Surinam | Pure line |
| Soekanandi | Pasoeroean | Purified population |
| Solo | Lombok | Pure line |
| Tjina (Tjere Kedoe; Enseng; Tjempo Deli; Kretek deli; Ho ing; Sisik melik) | Jokjakarta (introduced from China in 1914) | Pure line |
| Toentang | British India | Pure line |

Although the Extension Service had grown to a considerable size in the 1930s, staff and facilities were far from enough to reach all farmers. The calculation of Joosten that one third of the area could be covered with improved varieties was much more than the amount really achieved, estimated as 9% of the total rice area of Java and Madura.[54] These estimates covered the 1930s, a period in which not only new activities in seed distribution were employed, but also new technical opportunities for rice breeding were developed.

**Technical progress and political disruption**

The rice breeders in Buitenzorg primarily worked on selection of indigenous and foreign rice varieties. As described earlier, artificial crossing of rice was not considered very profitable because the hereditary structure of rice was considered too complex. As Koch put it in 1916: "Exact genetic analyses so far are not carried out, but one can assume, in analogy with what has been found in other cereals, that two different paddy species can vary in 15, 20 or even 25 genes, influencing visible differences."[55] The crossing or hybridisation of rice had to tackle two major constraints. In the first place it was difficult to decide about the parental material given the enormous number of existing varieties and the limited knowledge of rice genetics. Secondly, it was difficult to make sufficient crosses because the tiny rice flowers were easily damaged with instruments like needles and tweezers. But over the years the amount of knowledge about the hereditary structure of rice increased considerably and in the early 1930s a new leader of the breeding programme could state that artificial crossing offered "nearly unlimited possibilities, only constrained by the technical equipment, available to the rice selectionists."[56] This new head of the breeding station was J.G.J van der Meulen, graduated in Wageningen in 1926 and in the same year attached to the staff of Koch.

When Koch repatriated in 1933, van der Meulen became the head of the division for breeding of annual crops of the Department of Agriculture. He continued the selection programme, but criticised the work of his predecessors. He argued that Koch's breeding efforts had had little effect because he started too late with careful observation of the different lines and then excluded lesser performing lines too rigidly. Furthermore, van der Meulen argued that even for varieties introduced in the nineteenth century, like Carolina and Skrivimankoti, van der Stok and Koch erased too many of the offspring to make much progress.[57] The main reason for this rigid selection was because they followed the pure-line theory of Johannsen. Van der Meulen remarked that in rice "relatively few pure lines in the sense of Johannsen appear. Taking the notion of pure lines a bit more broadly, as perceived by most selectionists, the number of constant types in many land

[54] Van der Meulen, "De rijstselectie", 55. Van der Eng, *Agricultural growth in Indonesia*, 89.

[55] Koch, "De beteekenis van bastaardselectie bij padi", 506.

[56] Van der Meulen, "De rijstselectie", 50.

[57] Ibid., 40.

races of rice is in general relatively high."[58] The consequence of this interpretation was that the relevant material to select from increased and thus raised the chances to find outstanding types. Two other the developments further increased those chances. The first was the development of field experiments and mathematical processing of test results.[59] Van der Meulen worked with a specialised statistician, S.H. Justesen, to carry out the data processing. The second, and most crucial development, was the improvement of the technique of artificial crossing, resulting from van der Meulen's own experiments.

The critical step in crossing rice was the emasculation of the plant. Because rice was a self-pollinating plant, the anthers had to be take from the flower before it could leave pollen on the pistil. The tiny stamen had to be taken out with tweezers without damaging the other parts of the flower so that pollen from another variety could be used for fertilisation. In the first years of experimenting van der Meulen only succeeded in 5% of the attempted crosses and therefore he changed the technique. "Only a very small part of the husk was clipped, then the flower was taken with the tweezers and gently squeezed at its widest part. Subsequently the edges of the interlocking parts of the husk open up and the opening can be increased with the tweezers. (...) Soon after clipping the filaments will stretch and the anthers will rise above the clipped husk."[60] The adjustment considerably raised the number of successful crosses. In 1931 van der Meulen experimented with an entire new technique for emasculation, a water-jet vacuum pump. With a glass nozzle the anthers were sucked out the flower through a clipped opening, resulting in a 90% success rate with crossing. The improvement is even clearer when looking at the total number of successful crosses. In 1928 van der Meulen made 162 crosses, but in 1931 over 1600 rice crosses were produced in Buitenzorg.

The progress in crossing allowed van der Meulen to combine all sorts of varieties, indigenous as well as foreign. In 1949 van der Meulen had 140 promising hybrid populations from which 30 were used for further selection.[61] One of these was the so-called 40c population. This population was obtained from crosses between the Lati Sail variety, obtained from British India in 1930 and Tjina, a local adaptation of a Chinese variety. The cross was first made in 1934 and until 1940 the progeny was tested on the breeding station. Because of the war van der Meulen had to stop his breeding activities but when in 1947 the breeding work was continued 106 lines appeared to be in good condition. The 40c selections were adopted in many areas of Indonesia and other countries in the region, like the Philippines where it was used many years later by the International

[58] Van der Meulen, "De rijstselectie", 36.

[59] Ossewaarde, *Het proefveldonderzoek bij de rijstcultuur op Java*

[60] Van der Meulen, "Over het kunstmatig kruisen van rijst", 9.

[61] Van der Meulen, "Rice improvement by hybridization."

Rice Research Institute.[62] Van der Meulen, however, was not able to continue his breeding activities in the Dutch East Indies. In the article about the 40c crosses, published in 1951, van der Meulen introduced himself as "formerly head of the Subdivision for Annual Crops, Institute for Agricultural Research, Bogor, Indonesia." The independence of Indonesia, ratified in 1949, had disastrous effects on research activities because the new Indonesian government expelled all Dutch citizens previously staffing the colonial administrative services. Most employees of the former Department of Agriculture returned to the Netherlands. The only rice breeder left behind was Indonesian, H. Siregar. He continued various experiments but the budget and staff for rice research was almost zero in comparison with the colonial situation. Only some twenty years later the Indonesian government managed to set up a system of research and extension similar to that of the colonial period, supported by international development agencies.[63] The independence of Indonesia, however, did not imply that Dutch public sector rice research came to an end. Van der Meulen and one of his staff members, J.J. Mastenbroek, went to Surinam, a Dutch colony where rice improvement was an issue in entirely different circumstances.

## Mechanised rice cultivation in Surinam

Surinam was colonised first in 1651 by British sugar planters from Barbados. The Dutch acquired the colony in a peace deal in 1667 and continued the sugar plantations. The colonisers settled in the coastal plain and lived rather separate from the inland forest-based native inhabitants, primarily Arowak and Caraib tribes. The work on the plantations was done by slaves, shipped from (Western) Africa. In 1863 the Netherlands abolished slavery and to ensure that the plantations were supplied with enough manpower, the Dutch recruited labourers from British India. The first ship with the new labourers arrived in 1873 and from 1890 labourers were also recruited from Java to work on the plantations. Hindustani and Javanese families soon found out that the working conditions were nothing like the promises made to them and most of them started their own farms in the coastal areas.[64] The support of the colonial authorities for the plantation owners, and later the pressure on the Asians to stay in Surinam, was part of the general idea of the Surinam colony. Where the Dutch East Indies was treated as an exploitation colony with its own cultural identity, the Dutch viewed Surinam as a settlement colony, a sort of twelfth province of the Netherlands. Therefore an

[62] Barker, Herdt and Rose, *The rice economy of Asia*, 58-70.

[63] Palmer, *The new rice in Indonesia*.

[64] Bakker e.a., *Geschiedenis van Suriname*.

assimilation politics was designed that was supposed to neutralise the differences between the ethnicities and religions of the various groups. Dutch education, spread of the Christian religion and attracting young Dutch families were the main vehicles for the implementation of the policy.

The history of rice farming in Surinam starts in the seventeenth century when the first slaves from Africa were shipped to the colony. Accounts from the early nineteenth century make clear that most rice was planted on dry land, confirming African origin.[65] The African slaves were allowed to use small plots on plantations (*kostgrondjes*) to grow their own food. Escaped slaves, the so-called Maroons, fled into the inland forest and applied the same slash-and-burn method to grow crops as they were familiar with in Africa. With the arrival of Asian contract labourers experience in wetland rice cultivation was imported. The Javanese and Hindustani families that stayed in Surinam after their contract had ended primarily settled as rice farmers in the coastal plains, supported by the colonial government that cleared the swamp areas and laid out polders for the rice farmers. Other forms of support came from the Agricultural Research Station in Paramaribo. This research station was founded in 1903 and set up along the same organisational model as in the Dutch East Indies, although much smaller in size.[66] The main focus of the agronomists, however, was on crops that could be sold on the market, like cacao and coconut. There were no specialised agronomists for rice cultivation, nor a breeding programme for rice.

Agriculture in Surinam was not a very prosperous branch of the economy. Sugar cane appeared too costly when the planters had to pay for the labour and cultivation gradually declined. Towards the end of the nineteenth century, cocoa cultivation appeared to be a profitable alternative, but several diseases almost entirely eliminated the production in the early twentieth century. The Dutch government continuously looked for ways to stimulate surplus production, to deliver some returns for its investments in the colony. A notion that regularly appeared in the different policies was that the colony needed an input of fresh, ambitious and active young farmers who would function as an example to the apparently less active and adventurous population of the colony. Young Dutch farmers were considered the best in that respect and the government studied ways to attract them to Surinam. In the late 1910s the idea of colonisation by young Dutch farmers was linked with the idea of mechanised rice farming. As described earlier in this chapter, an experiment in mechanised rice farming was set up in the Dutch East Indies and in the same period the Dutch government sent Tj. Pyttersen, repatriated sugar manufacturer, to Surinam in order to explore possibilities for mechanised agriculture.

[65] Stahel, *De rijstcultuur in Suriname*. Oudschans Dentz, "De geschiedenis van den rijstbouw in Suriname." Geijskes, "De landbouw bij de bosnegers van de Marowijne."

[66] *Verslag Departement Landbouwproefstation in Suriname* .

### Mechanisation challenged

The report from Pyttersen appeared in 1922 and gives an overview of options for mechanisation in several crops. He expected most from an application to sugar cane, as in his opinion that crop would likely render the best returns.[67] Regarding rice, he saw opportunities as well, but only when a suitable variety for mechanised harvesting would be found and when weeds were controlled more effectively. He advised to wait for the results of the Selatdjaran project on Sumatra and do a similar experiment in Surinam. His conclusion was that agriculture with modern mechanised methods was very likely to be profitable and recommended the government to invest in infrastructure, primarily the construction of a seaport in the West. In his report Pytterson remarked that he had contacted the engineering firm van Dijk and found them willing to set up an experiment in mechanised agriculture.[68] Presumably scared off by the disastrous results of the Selatdjaran experiment the government took no initiative to follow up the report. Only in the 1930s the issue was taken up again and indeed the government then contacted the van Dijk company.

The deal van Dijk made in 1933 with the Minister of Colonies was that he would set up an experimental farm of 30 hectares to see if mechanised farming was a profitable business. The maximum government subsidy would be 157,000 guilders and, as van Dijk explained, success in the experiment would "create a basis for the ensuing colonisation of Dutch farm families."[69] The experiment would focus on rice instead of sugarcane and the major aim for the van Dijk company was to find a proper rice variety for mechanised farming. After several years it appeared that local rice varieties performed best on the experimental farm. The company only tested existing seed material. "Our attempts to take up selection ourselves were once and for all given up, because we lacked time as well as the required knowledge."[70] The report was written after six years of experimentation and van Dijk was very optimistic about the opportunities. His calculations of costs and benefits showed a positive balance, but he also made clear that it was difficult to find a market for the rice and that transportation costs were relatively high. That, however, should not prevent Dutch farmers from coming over and "in my opinion the next step should be that our Dutch government takes the initiative to encourage the creation of a Colonisation Company (...)."[71] Not everyone shared his optimism. In 1937 a report was published containing the results of an extensive study of the Dutch colonists in Surinam, including the van Dijk company.[72] The

[67] Pyttersen, *Rapport omtrent de uitkomsten van een voorloopig onderzoek*.

[68] Ibid., 83.

[69] Van Dijk, *Mechanische Rijstcultuur*, 7.

[70] Ibid., 15.

[71] Ibid., 124.

[72] Verkade-Cartier van Dissel, *De mogelijkheid van landbouw-kolonisatie voor blanken in Suriname*.

account of the experiment was that mechanised rice farming would be possible only when first class (fancy) rice was produced. But even with high yields, profits would not be very high and an investment of at least 25,000 guilders would be needed as starting capital.[73] The report gives the impression that Dutch settlers in Surinam were not very wealthy and the idea of colonisation by more Dutch farmers was considered an option only when the van Dijk farm or other experiments had yielded good results over several years.[74] Similar scepticism came from an agricultural expert in this matter.

One of the activities in the Selatdjaran experiment on Sumatra was a study trip to the United States in order to find out more about the details of mechanised rice farming. Agricultural extension officer M.B. Smits was assigned to the job.[75] Based on his experience Smits wrote a review article in 1934 in which he developed his ideas about the prospect of mechanised agriculture for the Dutch colonies.[76] Although Smits primarily wrote about the experiences in the East Indies, he drew a parallel with the experiments in Surinam and tried to dampen enthusiasm for mechanised rice farming. According to Smits the bottleneck was not the mechanisation of certain farm activities as such, but the control of weeds. He explained that the reason why mechanised rice farming worked well in the USA was because the rice crop was alternated with another crop in combination with a fallow period. Smits pointed out that a dry period was a necessary condition for proper weed control. In moderate climate zones plant growth decreases, allowing for a thorough clearing of the land but in humid tropical conditions like in Indonesia and Surinam plant growth was continuous and weeds a constant threat. "Therefore the prospects for a mechanised rice farm are not so positive. Only very small areas in the Dutch East Indies will be suitable for this farm type and it is very doubtful if such areas can be found in Surinam."[77] Smits further warned that taking other countries as an example is in general not very wise. "When the issue of mechanised rice farming is addressed, one fully has to let go of the American example and set up an entirely new system, based on well-established indigenous experience. In doing so one can also meet the biological requirements of the rice plant."[78] Despite the scepticism expressed by Smits, and the report discussed in the previous paragraph, the idea of mechanised rice farming was not forgotten. After the second World War food shortages in the Netherlands and emerging emigration of young Dutch to countries like Australia, Canada and South Africa

[73] Ibid., 230.

[74] Ibid., 289.

[75] Smits, *De rijstcultuur in Noord-America.*

[76] Smits, "Mechanische rijstcultuur en haar betekenis."

[77] Ibid., 622.

[78] Ibid., 629.

were new arguments to continue the attempts to make large-scale rice farming in Surinam possible.

### The Foundation for Mechanised Agriculture

In 1947 the Dutch government initiated a more structural investment plan for the Surinam economy. A special law was accepted that provided for a Welfare Fund financing several projects to an amount of 40 million guilders over five years.[79] A central target for the development aid was the layout of new polders for mechanised rice farming and in 1949 the Foundation for Mechanised Agriculture (*Stichting Machinale Landbouw*, SML) was raised. The SML, with its main office located in The Hague, was managed by a board of representatives of the Ministry of Overseas Territories, the Ministry of Agriculture, the Ministry of Finance and representatives of the colonial government of Surinam. In 1950 the SML initiated the implementation of rice polders, based on a report from a commission headed by the Wageningen professor in irrigation, W.F. Eijsvoogel. The commission made detailed analyses of soil, climate, natural vegetation and agricultural activities in the north west region of Surinam, along the Nickerie river. The commission advised to start with an experimental polder of 200 hectares, followed by the construction of several polders of 5,000 hectares each.[80] In the ensuing years the experimental polder and one production polder were laid out. To house the technical staff and other employees, a village was constructed that received the same name as the town where most of experts were educated, Wageningen.[81] The fact that the SML simultaneously constructed an experimental farm and a production polder makes clear that any question of whether mechanised rice farming was an option was not the issue, only how mechanised rice farming should be implemented. The experimental area, called Prins Bernhard polder, located further downstream on the Nickerie river, was the place where research for rice improvement was taken up.

The commission chaired by Eijsvoogel made a distinction between practical research and "strict scientific research". The first type of research mainly addressed the question how the various activities in mechanised rice farming should be set up to work. The latter category was considered to cover research for "new crops and varieties, the fertility question, soil improvement, the question of the structure and stability of humus, pest control, etc."[82] The commission advised to set up the scientific research in close connection with the Agricultural Research Station in Paramaribo. In the first two years most breeding activities for rice were

[79] Bakker e.a., *Geschiedenis van Suriname*, 131.

[80] Eijsvoogel, Van Beukering en Verhoof, *Rapport omtrent de ontwikkelingsmogelijkheden*.

[81] De Wit, *The Wageningen rice project in Surinam*

[82] Eijsvoogel, Van Beukering en Verhoof, *Rapport omtrent de ontwikkelingsmogelijkheden*, 195.

performed by the agricultural station in the capital but in 1951 the SML opened a breeding station for rice in the Prins Bernhard Polder.[83] The main breeder from the Paramaribo station was J.J. Mastenbroek, graduate from the Deventer school in tropical agriculture in the Netherlands. Before he arrived in Surinam in 1949 he worked (from 1938) in the Dutch East Indies at the Buitenzorg breeding station for annual crops. The leader of the SML breeding station in 1951 was his former boss, J.G.J. van der Meulen.

Mastenbroek and van der Meulen continued the work the van Dijk company started in the 1940s. To reach the main objective of the SML (export of large amount of rice to the Netherlands) the main targets for the breeders was resistance to lodging, to make mechanised harvesting possible, and grain quality, to make Dutch families eat more rice. After the official experiment ended, the van Dijk family decided to stay in Surinam and continue the rice farm and took up selection of rice varieties. One of the lines the van Dijks considered interesting was most likely a spontaneous cross between Rexoro, a variety introduced from the USA, and a local selection named D79. Further selection on this cross resulted in 1946 in a variety named Aurora, grown on a limited scale in the Nickerie district. Van Dijk went on to cross Aurora and Rexoro with Skrivimankoti, a type introduced by the labourers from British India, but both combinations did not result in varieties with extra qualities. Mastenbroek started to work with the rice populations of the van Dijk company. His work was rather successful and resulted in a line that was released in 1953. The shared credit of the variety was visible in the name, Dima. Before 1953 the SML mainly experimented with varieties imported from the USA, but between 1953 and the early 1960s the main variety grown in the rice polders was Dima.[84] In February 1951 van der Meulen arrived in Surinam and set up rice breeding in the Prins Bernhard Polder. The size of the experimental polder was increased to 500 hectares and the experimental fields for the breeding work stretched over some 10 hectares.[85] The breeding programme van der Meulen set up contained three elements. The first was observation of imported varieties. Van der Meulen had brought seed of about 19 Indonesian varieties, of which 16 were lines from his 40c selections. None of these performed very well in Surinam conditions but two other Indonesian varieties, Bengawan and Mas, appeared promising. Furthermore, the SML breeders tested over ninety varieties originating from British Guyana, Italy and the United States of America. The second line of research was artificial crossing, for which mainly combinations of varieties from Indonesia and the USA were used.[86] The last element in the breeding programme was selection of varieties already present in the region. Much selection work was

[83] *Jaarverslag Departement van Landbouw, Veeteelt en Visserij*. Jaarverslag SML.

[84] Ten Have, *Research and breeding.*

[85] Overwater, "Tien jaren Prins Bernhard polder, 1950-1960."

[86] Jaarverslag SML. Ten Have, *Research and breeding.*

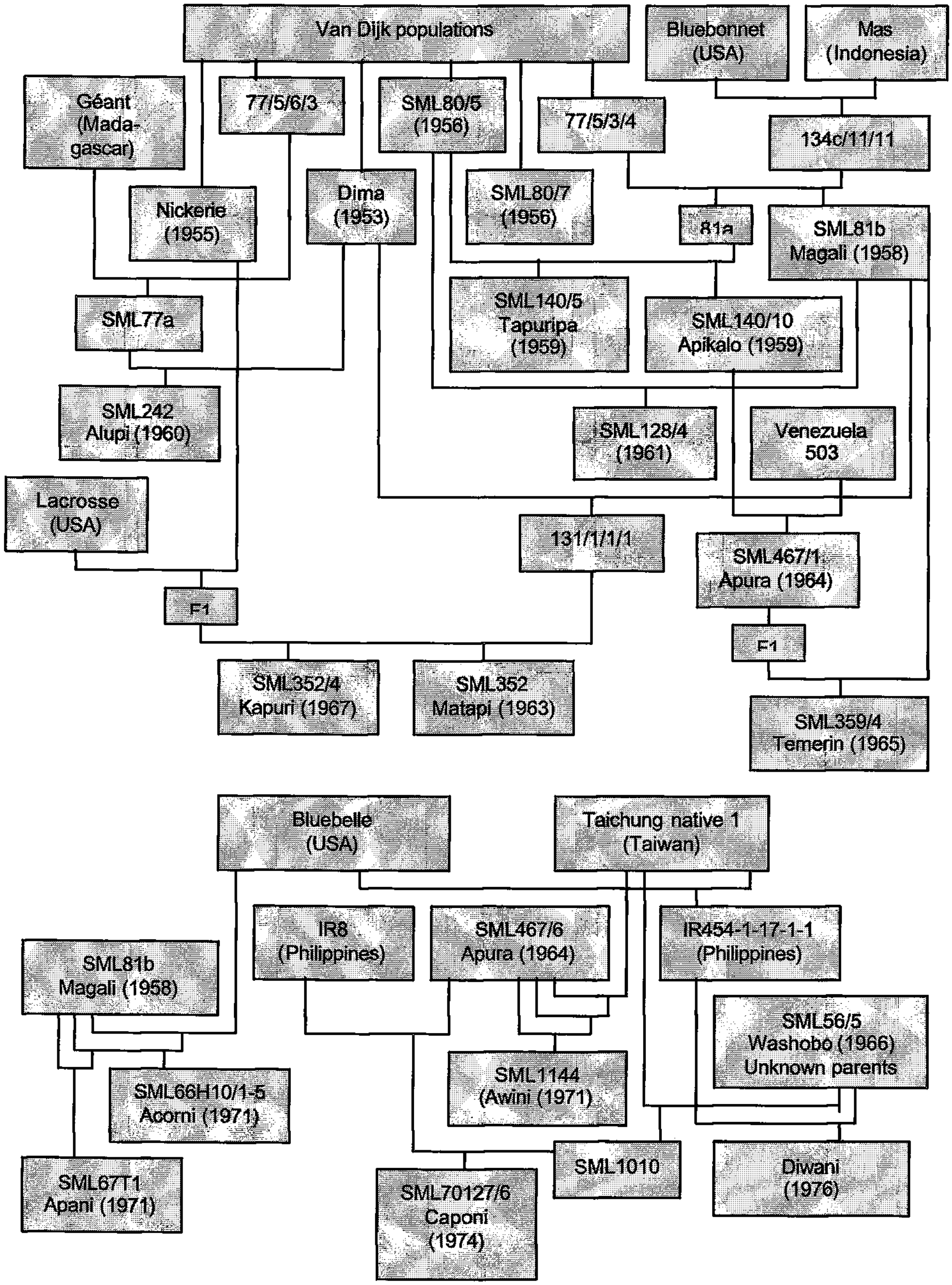
done on the Rexoro variety because it was considered the main seed candidate for the SML polders. Similar to Mastenbroek's approach, van der Meulen also screened the van Dijk populations. And again that appeared to be a rather productive strategy. The varieties that performed best in the SML polders during the 1950s all derived from van Dijk populations. Besides Dima these were Paradijs and Nickerie, released in 1955, and SML80/5 and SML80/7, both released in 1956.[87] As figure 1 makes clear, the main genetic base of all SML varieties were the populations assembled by the van Dijk company. For van der Meulen, who brought his rice crosses from the Dutch East Indies on which he worked for many years, it was maybe difficult to accept that these varieties were hardly useful in the Surinam conditions. However, he did not spend so many years in Surinam, as he retired and went home in 1955.

The breeder to succeed van der Meulen was H. ten Have. Ten Have studied at the Agricultural College in Wageningen in the late 1940s and early 1950s and did field work in the Prins Bernhard polder as an undergraduate. After graduation in 1954 he accepted a job-offer from the SML and worked for a year with van der Meulen before he replaced him.[88] Under the guidance of ten Have the number of variety tests, crossings, and the size of field experiments, all increased.

[87] Ten Have, *Research and breeding*, 252.

[88] Interview H. ten Have

**Figure 1:** SML rice varieties (Source: Ten Have, *Research and breeding*, 269. Anonymous, *De historie van Diwani*. Lieuw Kie Song and Van den Bogaert, "Surinam releases 'Diwani'- 21st rice variety", 24-25.)



The principles and application of the major techniques, crossing and selection, no longer raised serious constraints for the improvement of rice. Knowledge about the parental variety stock of the SML and the available techniques opened a large range of breeding options. During the period of ten Have the breeding work of the SML broadened its perspective. The SML rice breeders came in contact with other breeding stations focusing on rice in the region, urged on by a persistent disease in the rice crop called *Hoja Blanca*. Ten Have and his staff managed to breed varieties that were resistant to the disease and seed of the resistant varieties was exported to neighbouring countries. Based on that experience the SML decided to become more active on the regional seed market for rice. The activities of the SML became more an international and less a strictly Dutch enterprise in the 1960s. The breeders sought contact with the International Rice Research Institute (IRRI) in the Philippines, funded internationally to help secure food supply for the world population.[89] Experts form other countries, for example the USA, worked together with the Dutch on policy studies for the development of the Nickerie district.[90] The broader perspective of the SML not only related to the international contacts but also to the local situation.

**Local adaptation**

The principle behind the rice polders laid out by the Foundation for Mechanised Agriculture was to start rice farming from nothings. Although there was experience with the reclamation of the coastal area in the north-west of Surinam, and rice was not an entirely new crop in the area either, the SML polders, the cultivation method using heavy machinery and the introduction of young Dutch farming families, were all very new. The idea, as such, was not new for the Dutch, because in the 1940s the first of the two large Zuider Zee polders, based on the same principles, was finished and seemed a success worth repeating. The conditions in Surinam however appeared very different to those in the Netherlands. The objective of the SML, to have the rice polders run by Dutch farmers, appeared infeasible. According to the initial calculations a rice farm of 70 hectares would be profitable, but based on experiments in the first years it appeared that a family should run at least 1500 hectares to earn a decent living. The few Dutch farmers to settle in the early 1950s either accepted a job at the SML or returned to the Netherlands and the SML management decided to run the polders as a semi-private company, employing local field labourers. The ten-year anniversary of the SML was reason to evaluate the enterprise and several reports appeared. The various reports focused on different aspects of the rice polders, but they shared one conclusion. Rice farming by the SML was not cost-effective and the necessary annual

[89] Baum and Lejeune, *Partners Against Hunger.*

[90] Oberg and Hindori, *Groot Henar polder.*

contribution of the Dutch government (several hundred thousand guilders) would only be justified if the project were to have a considerable economic impact on the entire Nickerie district.[91] In other words, the SML had to interact with neighbouring farmers.

The Nickerie district of Surinam is for the larger part a swampy flat area with heavy clay soils from recent marine-fluvial origin. As explained earlier, the colonial government started with land reclamation at the beginning of the twentieth century to offer Asian families a piece of land to start rice farms. The farms had an average size of 2 hectares and in 1959 the region counted 16,239 farm units of which 1,779 were owned by Creoles, 8,047 by Hindustanis and 6,175 by Javanese families.[92] From 1960 the SML started to extend its technologies to these farmers, mainly by offering them cheap seed of the SML rice varieties.[93] There was, however, a crucial difference between the farming methods of the local farmers and the SML. As the name of the foundation suggests, farming on the SML polders was primarily done with machines. Sowing and weed control was done by aeroplane, harvesting by combine harvesters. The use of expensive machinery was (partly) earned back by reduction of labour costs and by growing two crops per year. Consequently, the main breeding goals of the SML were, besides yield and grain quality, reduction of growth duration to allow two harvests per year, reduction of stalk length and rigid stem structure to prevent lodging.[94] Where the rigidity of the stem was a favourable character for the SML farming method, for the local rice farmers it implied serious problems. The Asian families employed the same methods as in their mother countries, meaning sowing the rice in seed beds and transplanting it to the fields. The main difficulty with the SML varieties relates to the transplanting. The inflexible stalks of the SML varieties often broke when a bundle of young rice plants was split for transplanting, causing major losses of plant material. Furthermore, the SML varieties grew relatively slowly in the first weeks, meaning greater sensitivity to weeds and pests. The main varieties used by the local farmers were Skrivimankoti and D110, a variety introduced from British Guyana by the van Dijk company. In short, the criteria local farmers applied to rice varieties were different from the SML. Local farmers had little reason to switch to the SML varieties, even when yield is taken into account. In the ten years of existence the SML never managed to get a higher yield than the Surinam farmers in the area and on average the yields in the SML polders were 300 to 500 kilograms per hectare less. The productivity of the SML, however,

[91] Ubels, "Modernisering van de rijstbouw in Nickerie." Witte enJongerling, *Rapport inzake de werkzaamheden*. De Wit, *The Wageningen rice project in Surinam*

[92] Bakker e.a., *Geschiedenis van Suriname*, 81.Ubels, *Modernisering van de rijstbouw in Nickerie.*

[93] Oberg and Hindori, *Groot Henar polder.*

[94] Interview C.W. van den Bogaert.

was higher only because a second rice crop was grown in the dry season.[95] Therefore, the SML agronomists, in co-operation with the extension officers of the Department of Agriculture in Paramaribo, had to offer something extra to make the SML varieties attractive to Surinam farmers.

The solution found by the SML, in cooperation with the Surinam Department of Agriculture, was not to change the features of the rice varieties through a special breeding programme, but to change the farming conditions for local farmers by offering them cheap inputs. Rice seed, fertiliser and pesticides were provided at bargain prices. Moreover, when the crops met the SML quality standards, the rice was bought up and harvested with machines from the SML. The SML package was offered by contract. This form of contract farming was applied in the Nickerie between 1960 and 1966. In the first season only some ten percent of the farmers signing a contract actually met the quality standards and only few farmers signed a contract in the following year. Nevertheless, the farmers gradually adapted to mechanised agriculture. Some farmers bought a combine harvester from the SML and hired it out to other farmers and local rice merchants gradually began offering good prices for the SML varieties.

The SML breeding programme maintained its focus on the large rice polders. From 1966 the breeding division was headed by another graduate of the Agricultural College in Wageningen, C.W. van den Bogaert. Under his guidance growth duration and stalk length were further reduced. One of the varieties used for this purpose, Taichung Native 1, was received from the International Rice Research Institute. In eight years time growth duration was brought back from 150 to 100 days and length from more than 1.5 meter to less than 1 meter.[96] The Surinam farmers in the neighbouring polders adopted the new varieties, but at a much lower pace. In many cases they only moved to new rice types when the SML stopped multiplication of the older varieties.[97] In sum, the rice farmers in the areas surrounding the SML rice polders employed a sort of small-scale second-hand version of the SML rice cultivation. Put the other way round, the SML rice polders were a sort of model farm for the region. In the 1960s the second major objective the SML project, providing the Dutch market with cheap rice to overcome post-war food shortage, was superseded and the project was maintained as a sort of development aid project. When the Dutch prepared the independence of Surinam in the 1970s the SML project was gradually handed over to Surinam experts. Van den Bogaert left in 1973 and was replaced by P.A. Lieuw Kie Song. The management of the SLM was also placed in Surinam hands, directed by S. Shankar, who later became president of the Surinam republic. Both Shankar and Lieuw Kie Song were graduates of the Agricultural College in Wageningen. The

[95] Ubels, *Modernisering van de rijstbouw in Nickerie*, 41.

[96] Interview C.W. van den Bogaert.

[97] Anonymous, *De historie van Diwani*.

transfer of Dutch governance to Surinam hands implied the end of organised rice improvement based on an interaction of Dutch science and government. The Dutch experts returned home and the few Dutch rice experts working in Surinam from the second half of the 1970s were all employed through international or bilateral projects. Knowledge and experience in rice breeding was transferred to Dutch students until the mid 1980s by H. ten Have, lecturer in the Agricultural College in Wageningen.

## Conclusion

The involvement of the Dutch in rice improvement in the Dutch East Indies and Surinam was always a combined effort of science and government. The major driving force behind this combined effort was to secure food supply. In the Dutch East Indies the target was to feed the people of Java and surrounding islands with rice, with a minimum of rice imports. In the case of the mechanised rice project in Surinam much of the harvest was shipped to the Netherlands where regular food supply was disrupted by the Second World War. The effort of the Dutch government in food security had two major outcomes for the scientific and technical development of rice. One was creating a linkage between researchers, technicians and the local food producers. The second was a persistent attempt to produce rice on a considerable scale without the involvement of local producers.

It took several decades before a connection between science and Javanese rice farmers was established. When from the 1860s the colonial government first developed its concern with the local food situation, the focus was primarily on administrative measures, left to the responsibility of colonial civil servants with hardly any training and often no interest in agricultural matters. Two Inspectors of Agriculture in the 1860s and 1870s, Van der Poel and Sollewijn Gelpke, were aware that the knowledge of rice farmers in combination with organised experimentation might be a powerful instrument for the improvement of rice cultivation. But it took until the early 1900s before science was called on for assistance. The person to organise research for rice, Treub, was convinced that scientific research as such would suffice. Once the results of scientific research were clear, farmers would adopt the innovations resulting from research with only few incentives. His approach did not have any visible effects in the rice fields and Treub was put under pressure to do something about that, which he resisted. In 1909 he was replaced by Lovink, former head of the Directorate for Agriculture in the Netherlands, who was convinced that local instruction of rice farmers in combination with research was the key to success. His approach was implemented in the 1910s and remained the major strategy for the first half of the twentieth century. The policy change also implied a change in research strategy. Under Treub a breeding programme was set up that was based on detailed scrutiny of individual rice plants with favourable features and the offspring of such plants over several generations. The strategy was called line selection and although convinced of the method, the main rice researcher, van der Stok, advised the regional extension officers to do quicker forms of selection in consultation with local rice farmers. At the end of the 1910s the question what was best (line selection or mass selection in populations, resulting in line mixtures) became an issue of principle, but the leader of the government institute for rice breeding, Koch, took up again both strategies in the 1920s. By the end of that decade another rice breeder, to be his successor, was added to Koch's staff, van der Meulen. He refined the selection methods of his predecessors and had considerable success in developing a technique for artificial crossing of rice. In the 1930s the central breeding institute produced several varieties that were considered beneficial in Javanese rice cultivation. Despite the organisation of local selection stations, and multiplication and distribution of these better varieties, the estimated impact at the end of the 1930s was only about 9% of all rice planted. As several extension officers reported, there were not enough farmers voluntarily multiplying and reproducing the improved varieties, although they considered that this was a matter of time rather than a fundamental problem. In other words, the system of rice improvement set up in the Dutch East Indies was considered a proper system that would work well after it had grown and spread over the years. The colonial system, however, was never given the time to prove if this was indeed the case, as the independence of Indonesia at the end of the 1940s cut off all Dutch involvement in public services. Although rice breeders and extension workers seemed convinced of the principles of the system of rice improvement, higher officials in the colonial government probably were not. This bring us to the second outcome of government involvement in rice improvement.

The experimental rice polder on the plains of the Seladjaran river on Sumatra was an expression of the wish of the colonial government to have large amounts of rice to hand to distribute to the population of the Dutch East Indies, in combination with the dream of agronomists and agricultural engineers to control every aspect of rice growth. The experiment failed and for the Dutch East Indies it was never repeated. In Surinam, however, the Dutch continued to implement large-scale production of rice without all the labour inputs employed by traditional rice cultivation. One of the reasons the government continued with the experiment in Surinam was because the overall objective of the colony was to have land occupied by immigrants, preferably of Dutch origin. The effort to set up mechanised rice cultivation in the coastal plains of Surinam therefore was accompanied by the idea to bring over Dutch farmers to settle in the rice polders. Despite negative advice on both the social and technical aspects of mechanised rice cultivation, the government persisted and after the Second World War large sums of money were invested in the reclamation of swamp areas in the Nickerie district of Surinam. Gradually however it became clear that settlement of Dutch farmers and cost-effective rice production were hardly feasible and the objectives of the project were changed. The focus shifted from fully controlled rice cultivation by a semi-private company to a sort of model farm developing farming methods, rice varieties and machinery to be transferred to local farmers. In other words, the idea to grow rice without involvement of local farmers was abandoned.

The failed attempt to set up mechanised rice cultivation makes clear that the relation between science and practice in agriculture appeared rather difficult without mediation by local farmers. The impact of the breeding system in the Dutch East Indies makes clear that such mediation caused all sorts of problems by itself, especially when local farmers were Javanese instead of Dutch and rice and seed traders primarily Chinese. Nevertheless, a system where these mediators were circumvented never succeeded in the years the Dutch controlled Indonesia and Surinam.

# 7

# Numerical abstraction in agricultural science

## Introduction

Limitation and control of the fluctuation of living nature lies at the basis of agricultural science. Different disciplines have different ways to analyse, understand and control the instability of natural processes. Physiologists and phytopathologists for example often kill plants and animals to get a stable situation. Others, like physicists and agricultural-mechanical engineers, simply concentrate on more stable (i.e. non-living) elements in agriculture like water or machines. Another way of dealing with the fickleness of nature is to assume that phenomena and processes are very regular and stable. Once that assumption is made, the objects studied can be expressed in figures or equations. This principle of quantification or numerical abstraction is very common in many disciplines of agricultural science and the life sciences in general. Besides attaching numbers to plants and equations to processes, numerical abstraction also implies the application of the law of large numbers. What seems highly variable and deviating when looking at some individual cases might appear to be rather constant and continuous when considered in large quantities. The various solutions are often developed in combination, and they are not only employed by scientists, but by government administrators too. After all, stability and control are highly valued assets by state leaders. Science and government often joined forces in the imposition of numbers and standards, which is one of the elements in the story that follows.

The central question of this chapter is how quantification affects the perception of agricultural scientists regarding agricultural practice and agricultural science. To answer this question the chapter is divided in three parts, each containing an analysis of a different process of quantification. The first section is devoted to an analysis of economic statistics in agriculture. After a short general historical introduction of the origins of economic statistics in Europe the close connection between this form of administrative quantification and agricultural science is analysed, primarily in the colonial setting of Java. In the second part the use of inferential statistics in Dutch agricultural science is examined. Inferential statistics in agriculture comprises the mathematical techniques used to draw valid conclusions from field experiments. Besides mathematical techniques all kind of organisational interventions were necessary to make it a successful enterprise. The subject of the last part of this chapter is mathematical modelling. In the 1950s a discipline of agricultural science emerged in the Netherlands that applied mathematical-physical models to processes of plant growth. The emergence of this discipline from the late 1960s gave a distinctive swing to the process of quantification in agriculture. As remarked in the beginning, numerical abstraction is a tool used in many disciplines of agricultural science. In the following section three areas of agricultural science are selected in which quantification forms an essential element and consequently were rather influential on developments in other fields of agricultural science. The issues in the following sections are not bound to climate conditions, and so the stories switch from the Netherlands to the Dutch East Indies and back as required, but not without informing the reader about the location.

## Agricultural-economic statistics

The term statistics originates in late seventeenth century Germany and referred to a collection of remarkable facts about the state, *Staatsmerkwürdigkeiten*. Facts were remarkable when they provided insight into the functioning of the state.[1] Therefore the collections of remarkable facts primarily contained descriptions of the main possessions of the state and its population. Government administrations, in their turn, were highly interested in the state population and possessions as these formed the basic information for military recruitment and taxation. The major format of early statistics was descriptive, although numerical records were not uncommon. Studying the state was an activity of academics, state bureaucrats and amateurs. The exact rules of the game differed among each of these groups, but the activity as such became widespread and institutionalised in most universities and ministries of the German states. A major reason why statistics arose in the German states was an effective interaction between the different parties involved. The chain of ample material to study, well educated practitioners, university professors teaching students the fundamentals of statistics, and a state bureaucracy demanding well-trained statisticians, was a favourable condition for the discipline to flourish. Agriculture formed a crucial subject for the statisticians, because it was a main activity of the population and also because the land-owning elite had its power base in its agrarian possessions. A similar situation was found in Britain, and it was the gentlemen from the British Isles travelling through Germany looking for agricultural techniques, who first acquired an enthusiasm for statistics and applied the German example in their own country.[2]

The situation in the Netherlands of the seventeenth and eighteenth century was rather different. The major difference was the power structure of the Dutch state, a rather fragile balance between cities, provinces, the central assembly (*Staten Generaal*) and the House of Orange. The main result of this state structure was that information about people and possession was collected, but not by a centralised administration. Nevertheless, all ingredients for a development of statistics like in Germany were present. As in other nations the different authorities held their registers and files, and even at the universities statistics was lectured, but a powerful interaction between universities and state authorities (like in

[1] Hacking, *Taming of chance*, 24. Van Deursen, *Geschiedenis en toekomstverwachting*, 10-11.

[2] Hacking, *Taming of chance*, 16-34.

Germany) was absent.[3] In other words, statistics might have been invented in Germany and certainly was a big issue there, but the phenomenon could be present in other countries too, but not necessarily to the same degree. As Hacking puts it: "Every state, happy or unhappy, was statistical in its own way."[4] The main features of early statistics in the Netherlands of importance for the current story are its footing in the universities and a connection to agriculture.

Although the early development of statistics in Germany and the Netherlands was very different, there were linkages too. For example the German Everardus Otto, professor at the law faculty of the University of Utrecht between 1720 and 1739. His lectures contained all elements of German statistics, although the term was not yet coined at that moment.[5] He was one of the first to lecture in the subject, but over the decades other professors took up the issue as well. As already noted, statistics in those days was primarily descriptions with few figures or tables, and very close to historiography. "History is ongoing statistics, statistics is stationary history" as it was put by one of the Göttingen statisticians.[6] The association between statistics and history implies that the two academic professions were close related and mutual influence can indeed be traced, as for example in the career and position of Petrus Wesseling (1692-1764), a distinguished professor in antiquity and history, but also teaching statistics. Wesseling had not received his doctorate at the faculty of arts, where history was located, but in the faculty of law.[7] As most senior positions in government administration were allocated to law graduates, this is not a surprising feature. In all Dutch universities the chairs in statistics were located in the faculty of law, a situation that lasted until halfway through the twentieth century. Another feature of Dutch academic statistics that reveals its connection with state administration and the national economy is that the term statistics always came together with the term *staathuishoudkunde*, the discipline that studies the "state-household".[8] Until mid twentieth century all chairs had a combination of *statistiek* and *staathuishoudkunde* in their name.[9] Despite the examples of the eighteenth century, statistics and state-household studies were not very important academic issues before 1800. The change came with the formation of the Batavian Republic in 1795. With the French revolution in mind the government of the Batavian Republic introduced several laws and measures that changed the concept of the Dutch state, resulting

[3] Stamhuis, *Cijfers en Aequaties*, 50-53.

[4] Hacking, *Taming of chance*, 16.

[5] Stamhuis, *Cijfers en Aequaties*, 51.

[6] Cited in: Hacking, *Taming of chance*, 24.

[7] Roelevink, *Gedicteerd verleden*, 3. Stamhuis, *Cijfers en Aequaties*, 137. Van Deursen, *Geschiedenis en toekomstverwachting*.

[8] Stamhuis, *Cijfers en aequaties*, 140.

[9] Jensma en de Vries, *Veranderingen in het hoger onderwijs*, 340.

in a centralised state administration and the formulation of a national policy on various issues. One of those issues was agriculture.

## Agricultural statistics as science

The republican government of 1795 took over various tasks previously arranged by the provinces and cities. A National Assembly replaced the old central governing body, the assembly of provincial representatives, *Staten-Generaal.* The National Assembly was based on general elections and to define the electorate a national census was organised.[10] The outcome was published in 1796 and can be considered the first major statistical record on a national level. Three years later the government expressed the need for figures about agriculture. In 1799, minister of economic affairs J. Goldberg ordered the collection of information about Dutch agriculture. The major focus of the minister was control over the rinderpest that frequently infested the bovine livestock. The government decided to take drastic measures and have all infected cattle slaughtered. Farmers received financial compensation paid from a fund that was raised by a non-recurrent levy of two five-cent pieces on cattle above, and one five-cent piece on cattle below, the age of two. The epidemic died down but the impost was repeated over several years leading to a regular count of the livestock, gradually including other domestic animals.[11] From the early 1800s other agrarian activity was listed as well.

Goldberg assigned a special State Commissioner for Agriculture, J. Kops (1765-1849), who started to set up a more systematic agricultural statistics. In 1806 Kops published the States of Agriculture (*Staten van Landbouw*) being the first of an annual overview of agricultural statistics. For his descriptions of Dutch agriculture Kops made use of questionnaires he sent to the different districts in the Netherlands. The lists had to be filled in by special committees formed by members of the agrarian elite.[12] The 'states' were also published in a magazine that Kops published from 1803. In the first issues of the magazine he included the questionnaires with a general request to fill them in. The forms Kops used for his State of Agriculture contained 252 questions, divided over the categories, arable land, pastures, cattle, dairy products, products from forest areas, orchards and gardens, farm housing, wastelands and commons.[13] Like most statistics of those days the publication from 1806 is a verbal description of Dutch agriculture. The section on arable lands, for example, described the ploughing of the land, the fertiliser used, when and how seed is sown, where seeds were bought, after how many years the crop was grown on the same land again, which crops were grown,

[10] Stamhuis, *Cijfers en aequaties*, 202. CBS, *Geschiedenis van de statistiek*, 1-5.

[11] Van Wijk, "Geschiedenis van de landbouwstatistiek", 11-24. Maltha, "De gemeentelijke commissies", 56-64.

[12] Van der Poel, *Heren en boeren.*

[13] *Magazijn van Vaderlandschen landbouw*, 1804.

what weeds could be found and what pests occurred.[14] Incidentally Kops added some tables with market prices and climatic information, but the overall format was descriptive.

The defeat of the French Empire resulted in the creation of the Kingdom of the Netherlands in 1813. The new kingdom was a mixture of restored old structures and elements introduced by the governments of the Batavian Republic and France. A national agricultural policy was not considered necessary, and was left to provincial authorities. Jan Kops kept his mandate to compile a national agricultural statistics, a task he fulfilled until 1828. Meanwhile he had been appointed as professor in land-household studies (*Landhuishoudkunde*) at the University of Utrecht in 1816. For this reason he stopped issuing his agricultural magazine and the State of Agriculture became a separate state publication.[15] Like with general statistics and state-household studies, there was a close connection between agricultural statistics and land-household studies.

The chair Kops occupied in 1816 was one of three, divided over the universities of Groningen, Leiden and Utrecht, and installed in an attempt to stimulate and improve the agrarian sector. The chairs did not function very well, mainly because the chosen vessels through which the knowledge had to be transferred - preachers of the Dutch Reformed Church - refused to co-operate. The chairs implied the introduction of agricultural statistics as an academic discipline. The terminological resemblance of the statistics as state economy (*staathuishoud-kunde*) and statistics as agrarian economy (*landhuishoudkunde*) does not reflect a close interaction between the two disciplines. The two study fields not only focussed on a different terrain but were also located in different faculties of the universities. Nevertheless, the economic orientation in land-household studies was clearly visible, as all three professors mentioned that the main objective of the study field was to 'obtain value from the soil'.[16] But with economic principles alone agricultural practice was not served very well and the professors stressed that knowledge of botany, physics, chemistry, geology and several other disciplines was needed in studying the land household, elements the professors in land-household studies lectured themselves. Like statistics, the lectures in land-household studies were primarily descriptive. The lectures of Jan Kops, for example, followed exactly the same pattern as his statistics, first the arable land and the cultivated crops, followed by dairy farming, forest products, orchards and gardens.[17] The connection between agricultural statistics and land-household studies endured over the first half of the nineteenth century. Even in 1864, the

[14] Ibid.

[15] CBS, *Geschiedenis van de Statistiek*, 153. Van Wijk, "Geschiedenis van de landbouwstatistiek", 13.

[16] Kops, *Inwijdingsredevoering*, 1-5. Kleijnhoff van Enspijk, *Redevoering over de waarde*, 1. Wttewaal, *Redevoering over de Landhuishoudkunde*, 1.

[17] *Kort begrip van academische lessen*, 1-5.

second professor in land-household studies at the University of Groningen, H.C. van Hall (1801-1874), considered land-household studies only as a science "when the experience of farming men, not of one location, but of several locations, is compared with each other and brought to an adequate set of rules, that can be tested by the general laws of Nature and expanded on that base."[18] Van Hall was the only professor in land-household studies to attract a reasonable audience for his lectures. After the compulsory status of the lectures for theology students was repealed in 1828 the professors in land-household studies convinced the government that the chairs could only survive when not only registered students but also the general public could attend.[19] In the Groningen province a small (but in comparison to other regions rather large) farming elite existed, many of whom attended the lectures of Van Hall. Nevertheless, the chairs were abolished in the new Higher Education Act of 1876.

### Institutional separation

Jan Kops retired in 1835 but seven years earlier he had stopped compiling the national agricultural statistics. The government assigned the editing to a private society, the *Nederlandsche Huishoudelijke Maatschappij*, taken over in 1835 by another society, *Nederlandsche Maatschappij ter bevordering van Nijverheid*. The formal arrangement was that these societies obtained the official figures assembled by the provincial agricultural committees and put them together in national overviews, the Report of Agriculture (*Verslag van de Landbouw*). In 1850 the government stopped using the services of the private societies and assigned a representative of the agrarian community to compose the reports. From 1846 agricultural organisations organised annual meetings, the *Landhuishoudkundig Congres*. From the reports of these congresses it appears that the agrarian sector was not altogether happy with the organisation of agricultural statistics. At the first congress the issue was discussed and remained a major point on the agenda over the years.[20] The main problem congress members saw was the way agricultural statistics were assembled. It worked as follows. Mayors of the municipalities had to report about agrarian possessions and activities in their community. There were no regulations about how these reports should be set up, nor did the municipalities have special administrators for the job, so the prime source was mostly the village policeman. The agricultural organisations questioned the reliability of the figures gathered by policemen not trained for the job. Moreover, there were many problems with the various local units of measurement, as the metric system was not yet the common unit. The congress installed several committees and held

[18] Van Hall, *Grondbeginselen der wetenschappelijke landhuishoudkunde*, 1.

[19] Addens, *Vereeniging voor hooger landbouwonderwijs*, 24-45.

[20] *Verslagen Landhuishoudkundig Congres* (1846).

various competitions to come up with suggestions to improve the process.[21] The main thing proposed was the appointment of civil servants trained in collecting statistical information. In the last decades of the nineteenth century the collection of agricultural figures gradually improved, among others because the Agricultural Extension Service used its regional advisors to collect data. These extension officers were graduates of the State Agricultural School (*Rijkslandbouwschool*) established in 1876 in Wageningen.

Between 1860 and 1874 the official assignment to compile the Report of Agriculture was given to W.C.H Staring (1808-1877). In the 1840s and 1850s Staring had been member of the commissions installed by the agricultural congress to improve agricultural statistics and now he had the opportunity to implement the ideas. In 1875 Staring's assignment was handed over to C.J.M. Jongkindt Coninck (1834-1885) who, a year later, became director of the State Agricultural School in Wageningen. This event suggests a continuation of the connection between agricultural statistics and scientific education, but Jonkindt Coninck did not teach the issue to the students of the school, nor did a course land-household studies appear in the curriculum. The curriculum did contain several hours of state-household studies in combination with bookkeeping. Only in 1905 land-household studies reappeared in the curriculum, when S. Koenen was appointed as professor in *landhuishoudkunde*.[22] Koenen however was not involved in the compilation of the Agricultural Report. His teaching comprised the principles and features of the Dutch agrarian economy. Agricultural statistics was an important issue in the courses on land-household studies, but primarily as a source of quantitative information. Institutionally the two branches had split up, as in 1900 agricultural statistics was the responsibility of the ministerial Directorate of Agriculture.

## Agricultural statistics in the Dutch East Indies

The situation in the Dutch East Indies differed from that in the mother country. Until the turn of the eighteenth and nineteenth century the *de facto* government on the Indonesian archipelago was the United East Indies Company (*Vereenigde Oost-Indische Compagnie*, VOC). The authority of the VOC was visible in the statistical records it maintained. The company not only listed incoming and outgoing goods in the harbours but also kept records "of the deceased and buried residents, both whites and blacks, of the baptised children, of the married couples, of the Javanese residing in Jakarta, of the provided and seized trade licenses, of the branded, whipped, caned and hanged convicted and so on."[23] The VOC went bankrupt in 1799 and official rule of the Indonesian archipelago was handed over

[21] Ibid., 1847 and 1860. Van Wijk, "Geschiedenis van de landbouwstatistiek", 16-21.

[22] *Programma van het onderwijs*, 1876-1905. Van der Haar, *Geschiedenis I*, 130.

[23] Paulus, de Graaff, en Stibbe, *Encyclopaedie van Nederlandsch-Indie (IV)*, 104.

to the government of the Batavian Republic. This only lasted a few years as the Netherlands was considered a vassal of the French state, and therefore the British invaded the colonies and ruled for several years before handed over to the Dutch again in 1816. Between 1800 and 1850 the various governors made several attempts to set up a statistics of Java and other islands, but it was such a huge operation that it never resulted in any reported overviews. In 1827 the former governor of the Moluccas, a group of small islands, was ordered to make a summary of the existing statistical material. His report, however, was destroyed in a fire caused by a revolt of the Chinese population. The only records that were rather well preserved were the lists with imported and exported goods.[24] The lack of proper statistics of the population and possessions of the Javanese however did not prevent the government from setting up a system for taxation.

The indigenous inhabitants of Java were much more numerous than the European residents. In spite of the relative wealth of the latter even a small levy on the many Javanese would result in high revenues. The official argument for taxation was that the indigenous population had no formal system of land-ownership and the colonisers, therefore, considered the land as state property. In that light the indigenous population used the land from the colonial rulers and should be charged rent. The first steps to set up a land-rent system were taken by the British governor, Raffles. He introduced the so-called village settlement system, as applied in British India. The levy was a percentage of the rice harvest, and collected from the village. The villagers themselves had to decide how to produce the taxes. In the last years of British rule Raffles tried to introduce a system based on individual property, as he considered the village system prone to coercion from village elders.[25] When the Dutch government took over in 1816 the village system was revived, with the argument that there were no reliable data about private ownership. But even with a village system the colonial government needed information about the land in order to assess a tax rate that corresponded with area and production. For more then sixty years such data were entirely lacking, implying that taxation was, in fact, a bargaining game between collectors and village chiefs.[26] From the 1930s until the 1860s the land-rent system received little attention because the main source of income for the Dutch government came from the Culture System (*Cultuurstelsel*) implying a forced delivery of agricultural products and labour by indigenous farmers.[27] In 1870 the Culture System was abolished and the colonial government started new attempts to improve the land-rent system.

[24] Ibid., 105. Scheltema, "De statistiek van den Inlandschen Landbouw", 296-339. Boomgaard en van Zanden, "Food crops and arable lands."

[25] Van den Doel, *De stille macht*, 35-48.

[26] Paulus, de Graaff, en Stibbe, *Encyclopaedie van Nederlandsch-Indie (I)*, 235.

[27] Fasseur, *Kultuurstelsel en koloniale baten.*

The first proposal to improve the land rent system was formulated in 1872. In that year the government imposed a system in which the tax assessment had to be based on two variables. One was the average harvest over a three-year period and the other a classification of rice prices over a ten-guilder interval. The land rent would be set on a certain percentage, say 20, of the lowest amount of the price class. So if for example in one area the rice harvest yielded 500 kilogram a hectare with a price of 7 cents a kilogram, this resulted in 35 guilders falling in the category 31-40. When the total rice area was 10 hectares the village had to pay 20% of 310, i.e. 62 guilders. To relieve the administration the land rent was fixed for five years. The crux of the land rent system and also its weak spot, was that it depended on two unknown variables, acreage and productivity. As can be derived from the example, the yield had a rather large effect on the tax rate. Reliable yield figures, however, were hardly available and therefore most administartors continued to determine the land-rent in a bargain with the village elders. Moreover, after the first five years of the new system it was decided to charge the same amount of land rent for another five years without making new estimations. This decision was repeated several times until an acceptable solution for the problem was found. One other attempt to improve the system was made in 1879 by J.H.F. Sollewijn Gelpke, chief inspector for sugar and rice culture. He proposed to split up the land rent into a fixed amount over the acreage, and a weighed amount over the rice production.[28] This implied a separation of the two variables but as reliable figures for both factors were still lacking error rates were still considerable and because the proposal was considered to result in extra work for the administrators it was rejected.

It turned out that not rice yields but land acreage was the first element for which more reliable figures were produced. In the last decades of the nineteenth century administrators and land surveyors made considerable progress in listing the division of land and its usage. These data formed the basis of a new decree on land rent in 1907 that first only covered several residencies, but in 1914 the entire Java. Although the way in which the system was imposed differed over the residencies, the general principle was that the parcels of land became the central units on which the land rent was based. Where a parcel ended and another started was determined by the Topographic Service (*Topografische Dienst*) and based on partitions like roads, ditches and the like. The relative weight of a piece of land was based on a classification of usage and fertility. The official allotment of the land did not necessarily fit the ideas the Javanese had about ownership and partition. To prevent conflicts the colonial government put the village chiefs in charge to collect the land rent. With the establishment of the Topographic Service the area was no longer considered a problematic factor and the only uncertain

[28] Sollewijn Gelpke, *Ontwerp van eene landrente Ordonnantie*. Paulus, de Graaff, en Stibbe, *Encyclopaedie van Nederlandsch-Indie (I)*, 239.

variable was the productivity. The productivity was estimated via trial cuttings. As rice was the main crop grown by the Javanese, administrators randomly threw a frame in a rice field, cut all the rice in the frame, weighed it and calculated the total yield.[29] This taxation method lasted, with some modifications, for the rest of the colonial period. In the twentieth century however the productivity of the land became subject of economic field research performed by the colonial Extension Service.

## Indigenous farm-household studies

The implementation of the land rent system was primarily a matter for the colonial officials of the Interior Administration (*Binnenlandsch Bestuur*) who collected the tax fees and controlled the books of the village chiefs. The information on which the land rent was based, however, was divided over several branches of the colonial government like the already mentioned Topographic Service. In 1905 the colonial government created a Department of Agriculture and this service became responsible for figures about agriculture. For six years the work was limited to compiling overviews of agricultural production for the annual Colonial Report (*Koloniaal Verslag*) but these figures primarily concerned plantation agriculture. From the 1910s the Inspection for Agriculture gave more balanced attention to European-run plantation agriculture and indigenous agriculture, and gradually the Department of Agriculture reported about the condition of the various food crops on a more regular basis.[30] There were two divisions of the department involved. One was the Extension Service, set up in 1912, providing data through the regionally based extension officers. The other was the Statistical Bureau, created in 1915 and by several reorganisations transformed into the Central Office for Statistics, *Centraal Kantoor voor Statistiek*. The two divisions worked together in the production of reliable figures about the productivity of indigenous agriculture.[31] The colonial government used the information for determining the land rent, but the Extension Service had other uses for the data.

In a circular sent to all extension officers in 1921, head of the agricultural division J.E. van der Stok pointed out that besides some incidental studies of small regions, hardly any knowledge was available on the farming methods of the Javanese. Therefore he ordered the collection of data on (1) the amount of hours spent on ploughing, puddling, planting, weeding, harvesting; (2) the division of labour among family members, relatives and wage labourers; (3) the compensation (in money, food or part of the harvest) given and received for

[29] Ibid., 239-240. Verweij Mejan, *Landrente-belasting-werkzaamheden*.

[30] Scheltema, "De statistiek van den Inlandschen Landbouw", 296-339. *Regeringsalmanak van Nederlansch Indië.*

[31] Bagchus en Scheltema, "Beschouwingen over de taxatiemethode."

various activities.[32] No further details were given about the method of analysis. "The way in which these and analogous data can be collected in a truthful way, I can leave to your insight. I only want to point to the desirability of selecting farms typical for an area and to follow, so to say, the farmer on his heels."[33] The circular of Van der Stok was the official start of a large number of studies into the farming methods and household management of people in rural areas of Java. As Van der Stok already mentioned, studies on the local farm economy were not an entirely new phenomenon. Since the introduction of the land rent system early in the nineteenth century several inquiries were set up to determine the profitability of indigenous farms, to justify the imposed land rent. Moreover, in the first decade of the twentieth century an extensive investigation into the welfare of the indigenous people was set up, in order to determine the main targets of the welfare policy of the colonial government. The Extension Service tried to set up a more systematic study of indigenous farm households. The major aim of these investigations was to monitor the needs and wants of the indigenous farmers, providing insight in the type of technologies and knowledge to be introduced. Some colonial officials gave a scientific swing to the investigations.

The scientific aspirations of some of the colonial officials comprises several elements. One was a connection between farm-household studies and international agricultural economics. A.M.P.A. Scheltema, for example, started his first major analysis of 1923 with references to definitions of agrarian economy by primarily German scholars. Another example is the work of E. de Vries, referring to work of economists from the United States as well.[34] Scheltema and De Vries discussed the literature to formulate theoretical notions of the economy of farm households. Scheltema, for example, defined his farm analysis as "the analysis of the influence that different factors have on the results of the farm."[35] This reads as a rather empty statement, but with such definitions the researchers tried to strip the data they gathered from their locality and temporal context. De Vries formulated this as follows. "In the current stage a farm analysis can be called ideal when it is set up in such way that the material can be classified in many different formats. In that way the material can also be used for testing different theories by researchers in a later stage and even when the theoretical perception of the farm may be entirely different, the material will still be useful."[36] The major method to reach this interpretative flexibility was by quantifying the studied farm activities and processes. From a quantitative account of farm activities various notions were formulated, expressing the state of a farm and its development. An early example

[32] Cited in: Scheltema, *Ontleding van het Inlandsch landbouwbedrijf*, 76.

[33] Ibid, 75.

[34] De Vries, "Cultuur- en bedrijfsontledingen", 110-177.

[35] Scheltema, *Ontleding van het inlandsch landbouwbedrijf*, 9.

[36] De Vries, "Cultuur- en bedrijfsontledingen", 133.

is the extension officer M.B. Smits who sketched in 1916 a development of indigenous agriculture from a stage of shifting cultivation via a stage of permanent labour extensive farming to the labour intensive sawah rice farms. Smits explained that "the intensity of agriculture does not primarily depend on the development and technical knowledge and skills of the farmer, but on the economic principles of the farm. (...) In general one can detect that, even if the native does not know anything about the yield of his farm, the intensity of the farm is in miraculous harmony with the economic conditions."[37] Intensity was a measure of several quantitative elements, like labour input, capital input, returns and so on. Put in abstract numerical terms, indigenous farms showed all sorts of corresponding features and processes, or as De Vries explained, "one can predict that mostly the farms will only show quantitative differences and that there is a gradual transition from very low developed to very complicated farms."[38] The quantitative theoretical accounts of indigenous farm-households not only had scientific value, but were also used to create a positive image of indigenous farmers, and indirectly of the Extension Service.

It is difficult to assess the way the Dutch colonial rulers perceived the life and work of Javanese farmers but a statement of Treub, the first director of the Department of Agriculture, most likely gives a good impression. In 1910, looking back on his work as director of the Department of Agriculture, he sketched a pessimistic future for indigenous agriculture, because "the native has a complete lack of economic insight."[39] With the farm-household studies the colonial official tried to prove the opposite and many expressions of this can be found. As Scheltema and another extension worker, G.J. Vink, put it in relation to the introduction of improved rice varieties. "The native farmer seeks in many areas for better varieties. It is a myth that he would be so conservative that he does not like better varieties, unless of course taste and price differences or other adverse characteristics make the better products of little extra economic value."[40] Back in the Netherlands Vink explained in a lecture the positive effect of the farm-household studies. "The major profit was that the understanding gained ground that the native farmer in general, and especially on densely populated Java, was very nicely adjusted to his environment, so considering his conditions worked in a very rational way."[41] A rational farmer could well cooperate with the rational colonial agricultural services and the farm analyses provided a scientific argument for the introduction of technological innovations. Scheltema formulated the overall aim of the analyses in 1923 as 'to increase the contact with the indigenous farmer'.

[37] Smits, "De ontwikkeling van den natten rijstbouw", 471; 482.

[38] De Vries, "Cultuur- en bedrijfsontledingen", 111.

[39] Treub, *Landbouw*, 29

[40] Vink en Scheltema, *Overzicht van de productiviteit*, 200.

[41] Vink, "Beschouwingen over den Indischen Landbouwvoorlichtingsdienst", 318.

De Vries stated seven years later that the results of the research might lead to "considerations about the way farms will respond to various economic conditions, price fluctuations, road construction, irrigation etc."[42] On a smaller level the analyses provided insight into the need for and impact of intensification, introduction of new varieties, fertilisation, crop rotation and education.

**Agrarian economics institutionalised**

The examples in the previous section show how the farm analyses conducted by the colonial Extension Service were based on principles of economics as a scientific discipline. Not all extension workers had a scientific ambition but several representatives entered academia. Besides, the Extension Service was not the only operating base for the tropical rural economists. Scheltema, for example, entered the Department of Agriculture working in the office of Agricultural Inspection and moving on to the Central Office for Statistics where he became head of the agricultural division in 1927. Scheltema (1931), De Vries (1931) and Vink (1941) received their doctorate titles in Wageningen, all on economic subjects. Besides Wageningen the University of Indonesia was also an option for defending a thesis, as another member of the colonial Extension Service, agricultural consultant Timmer did in 1947.[43] The supervisor of Scheltema and De Vries was J.C. Kielstra (1878-1951), a law graduate from Leiden University who became professor in colonial state and criminal law, colonial economics (*Indische landhuishoudkunde*) and colonial agrarian law in 1918. From 1926 he lectured on the same issues at the University of Utrecht. Kielstra left both chairs in 1936 to become governor-general of Surinam. The vacant chair was occupied again by a law graduate, A. Neijtzel de Wilde. The background of these professors shows that the connection between economy and law, originating from the eighteenth century, was still an observable phenomenon at Dutch universities in the 1930s. However, the 1930s was also the decade in which economics as a separate university discipline emerged in the Netherlands.[44] The same development can be traced at the Agricultural College in Wageningen.

In the period 1939-1946 several persons lectured on tropical land-household studies, on a temporary basis. One of these lecturers was G.J. Vink (1892-1944). Vink retired in 1937 after more than twenty years working for the colonial Extension Service. He settled in Wageningen where he worked on a thesis defended in 1941.[45] His promotor was J.E. van der Stok, professor in Colonial Agriculture and it was he who invited Vink to teach colonial land-household studies

[42] De Vries, "Cultuur- en bedrijfsontledingen", 134.

[43] Timmer, *Object en methode.*

[44] Wilts, *Economie als maatschappijwetenschap.*

[45] Vink, *De Grondslagen van het indonesische landbouwbedrijf.*

to his students.[46] After the war the Agricultural College looked for a new professor and in 1947 E. de Vries was appointed as professor in land-household studies of the overseas territories, agrarian law, state law and criminal law of the Netherlands Indies.[47] De Vries was very active in several commissions of the Wageningen senate. One of these commissions had to investigate the possibilities of a separate study programme in economics and the positive advice was accompanied by the following argument. "Because sensible intervention in society is only possible when there is a profound understanding of society, the government should recruit agricultural-economic experts able to take up the scientific preparation of such measures and to participate in their arrangement and implementation."[48] The establishment of a new study programme in economics, with a Dutch and a tropical specialisation, implied the institutionalisation of agrarian economics at the Agricultural College in Wageningen. The name that was used for the discipline remained land-household studies (*landhuishoudkunde*).

One of the driving forces behind the new study programme, and the connected chair in tropical land-household studies, E. de Vries, was a former official of the colonial Extension Service. In 1950 De Vries moved to a position in the World Bank and the chair remained vacant for two years. The new professor in tropical land-household studies, without the law subjects, was J.A van Beukering. Although van Beukering had very few publications to his name and (due to the Second World War) never finished his doctoral thesis, he was considered the best candidate because of his experience as an officer in the colonial Extension Service. Nevertheless, Van Beukering is characterised as having reinforced the theoretical basis of tropical agrarian economy.[49] He did not profess his subject very long as he died in 1957. His successor, J.H.L. Joosten, was also a former member of the colonial Extension Service and again the main reason was his experience in the colonies and other tropical countries, not his "theoretically founded knowledge of economy".[50] The appointments of these three professors, and the development described of farm-household analyses by colonial extension officers, makes clear that the discipline is a product of the colonial Extension Service. In other words, the numerical abstraction of the activities of Javanese farmers induced the abstraction of extension work in the Dutch East indies into a scientific discipline, institutionalised at the Agricultural College in Wageningen.

[46] Van der Haar, *Geschiedenis I*, 329.

[47] Ibid., 422.

[48] *Archive Lh*, 2328.

[49] Van der Haar, *Geschiedenis II*, 106-109. *Archive Lh*, 2487, 2488.

[50] Ibid.

## Mathematical statistics

In the previous part the step from agricultural statistics as primarily a descriptive academic discipline to (tropical) land-household studies as merely quantitative activity has not received much attention. The numerical and mathematical components of statistics are the subject of this part. The central question is how mathematical statistics can be used for the creation of reliable data about agricultural practice. Although this question was certainly crucial for the emergence of (tropical) land-household studies or agrarian economy this discipline will receive far less attention here than another activity of the agricultural scientist, field experimentation. The roots of mathematical statistics go back to early nineteenth century.

In Germany, the country where statistics as a description of 'remarkable facts about the state' was more or less invented, the very same activity rather quickly vanished, and in the 1830s and 1840s it was close to extinction. Statistics revived in the ensuing decades as a numerical social science rather than as a descriptive political one, a development that started mainly in France and Britain.[51] The new approach quickly spread through Europe and one of the best known pioneers in this new numerical social science was a Belgian, L.A.J. Quetelet (1796-1874).[52] The central feature of the shift was that the description and listing of social phenomena was replaced by seeing these phenomena as physical quantities with a normal distribution. This normal (or Gaussian) distribution is graphically represented in the well-known bell-shaped curve. The revolutionary aspect of the work of Quetelet was not only that he applied physical laws to biological and social phenomena but that by doing this he also created ideal or abstract properties of a population. "Because these could be subjected to the same formal techniques they became real quantities. This is a crucial step in the taming of chance. It began to turn statistical laws that were merely descriptive of large scale regularities into laws of nature and society that dealt in underlying truths and causes."[53] The conceptual change might be regarded as a revolution - the realisation of the concepts in the different fields of science dealing with statistics was a far slower process.

In the Netherlands it was Rehuel Lobatto (1797-1866) who first introduced the statistical thinking of Quetelet. Lobatto was a sort of amateur-mathematician who aspired to become professor in mathematics but was most of his career employed by the government administration. His mathematical qualities and interest in the work of Quetelet was not very well rated by either professors in statistics and state-household studies, or by mathematicians, who did not really know how to

[51] Gigerenzer e. a., *Empire of chance*, 48-53.

[52] Ibid. Hacking, *Taming of chance*, 55-63.

[53] Hacking, *Taming of chance*, 108.

handle Lobatto.[54] What worried the professors in statistics and state-household studies most was a proper institutional arrangement of a national statistics, underpinned with mathematical formula or not. The abstractions of Quetelet and Lobatto were perhaps a bit too much for the economic statisticians, although they were certainly aware that numerical abstraction was an important tool to come to viable understanding of data. The same counts for the persons active in the organisation of agricultural statistics. For example, W.C.H. Staring, assigned by the national agricultural congress to formulate a proper arrangement for agricultural statistics, stressed in his report that "the collected statistical specifications will out of its nature consist of numbers, partly representing the true numbers, partly however based on estimations and valuations. (...) An account of the credibility, of the degree of probability, and of the way in which the estimates are made, cannot be omitted so that care is taken in drawing conclusions."[55] Staring shows an awareness of the difficulties of numerical abstraction in relation to agricultural statistics. But like the economic statisticians, the main concern for Staring was not what kind of mathematics to apply to the data, but how data collection could be organised properly. Mathematicians, however, did not have to wait on that, as large sets of data from various phenomena were available for them to juggle with equations and figures. In result, the development of mathematical statistics in the early years did not focus on economic statistics, but on areas where data sets were available, mainly genetics and field experimentation.

### What is a viable test?

The area where the developments in mathematical statistics and agricultural science interacted most intensely was inference of data derived from field experiments. Experimentation is a crucial process in agricultural change and an activity employed by farmers and scientists alike. For farmers the main question mostly is if a certain change or innovation had an effect on their field, based on a balance of experience and trial and error. The early scientific agricultural experimenters did in fact the very same thing with the exception that they were not so much interested in an effect on one field as in general statements valid for large areas. To come to such conclusions the experimenters had to find out whether a certain effect, say a ten percent increase in yield, was caused by the variable under investigation, say fertiliser dosage, or was the result of the natural variation of the fields. The ultimate solution of the problem came in the 1930s and was developed by the Englishman R.A. Fisher (1890-1962), at the time chief

[54] Stamhuis, *Cijfers en aequaties*, 67-131.

[55] *Verslagen Landhuishoudkundig congres* (1847).

statistician of the agricultural experiment station in Rothampstead.[56] Fisher synthesised two solutions of two problems that were until then merely treated separately: significance testing and experimental design for complex processes such as agriculture. Both elements were subject of exploration by scientists for long. Significance testing goes back to the very beginning of the mathematics of chance, but the twentieth century version owed much to error theory. "Error theory made use of significance tests with a slightly different purpose - not to reject hypotheses based on data, but to reject discrepant data (outliers) based on hypotheses about their distribution."[57] This was a well-developed area of study in the late nineteenth century and rooted principally in astronomy. The second element, experimental design, is more directly related to agriculture and areas with similar problems like medicine. Especially in Germany, agricultural research resulted in much reflections upon the process of experimentation, resulting in insights that came close to those worked out by Fisher.[58] The issues that concerned Dutch scientists active in agriculture during the end of the nineteenth century show that they were mainly puzzled by the second issue.

In the Netherlands, as well as in the Dutch East Indies, there were two complicating factors besides the methodological issue. One difficulty was that most experimental plots also functioned as demonstration plots. The other problem, related to the first, was that the experiment/demonstration fields were often run by officials with no special training in agriculture, or awareness of complications of inference and reliability. The latter element was most prominent in the Dutch East Indies. Especially the demonstration fields for indigenous agriculture were supervised until the 1900s by colonial civil servants with hardly any agricultural background. From the 1870s the colonial government put some effort in the improvement of indigenous food crop production and field trials, combining demonstration and simple experiments, were considered a solution. Besides a limited knowledge of agriculture, most administrators lacked interest in the subject and, consequently, results were far more important than method. The official Colonial Report of 1894, for example, stated that a resident received a thousand guilders to award farmers whose experiments had the best results.[59] Although there are also examples of more enthusiastic and experienced officials doing experimentation, the varying and complex situation of indigenous food crop production was not very favourable for field experimentation. Conditions were better in the Botanic Garden in Buitenzorg where researchers in the late nineteenth century worked primarily on cash crops and plantation agriculture. But even in plantation agriculture, experimentation and demonstration went hand in

[56] Gigerenzer, *Empire of chance*, 70-109.

[57] Ibid., 80.

[58] Ibid., 85-90.

[59] Ossewaarde, *Het proefveldonderzoek bij de rijstcultuur op Java*, 24.

hand. The few agronomists with a sharp eye for the complications of experimentation criticised this combination. One such agronomists was A. van Bijlert, researcher in tobacco who wrote an article in 1900 about experimental design. He pointed out that a separation of experiment fields and demonstration fields was crucial for solid experimentation. In the rest of the article he made ample description of the conditions and design of the experiment. The soil type should be representative for the area, the plot should be horizontal and homogeneous, not located close to a river and should not exceed ten by ten meters. Plots had to be doubled, set up in two rows of a certain number of plots, depending on the kind of experiment. Besides details about the plots, Van Bijlert also explained that seed must be clean and pure and that plant material should come from one seedbed.[60] Besides the natural conditions, the human factor should be kept in mind as well. Preferably one assistant should do all the work. "It is also desired that the coolie (...) has no interest in a larger or smaller yield, but receives a set price in advance for the crop; to avoid the risk that he will make an effort to improve a less favourable crop condition that is part of the test, leading to results with no value."[61] In short, his message was that variation that might disturb the experiment should be avoided as much as possible.

Descriptions similar to the article of Van Bijlert, can be traced in several journals in the colonies as well as the Netherlands.[62] It makes clear that researchers were aware of the influence of the experimental conditions on the results. A detailed description of experimental conditions informed other researchers about proper experimentation, but also provided insight into the experiments, so that agronomists could form a judgement about their validity. Because a general mathematical method to compare experiment results was lacking, experience and personal judgement were the main tools to assess results of experimentation. In the first decades of the twentieth century, however, mathematical methods gradually advanced.

### Including mathematics

The conditions in the public services for agricultural experimentation were a bit better in the Netherlands. It was similar to the situation in the colonies, in that experimentation and demonstration went hand in hand. But the officials in charge of the experiment fields were organised in the Agricultural Extension Service (*Landbouwvoorlichtingsdienst*) active since 1892. Although all the extension workers were trained at the State Agricultural School in Wageningen, they had only a limited insight into the mathematical elements of field experimentation.

[60] Van Bijlert, "Korte toelichting", 58-70.

[61] Ibid., 68.

[62] *Landbouwkundig Tijdschrift* (1896), 94-95.

One of the first agricultural researchers who introduced the issue of statistical analysis of field experiments to Wageningen graduates was J. Hudig. Hudig studied chemistry at the Polytechnic in Delft, and at the universities of Hannover and Berlin. In the Netherlands he worked for several agricultural experiment stations before he became professor in agricultural chemistry at the Agricultural College in 1930.[63] Hudig was familiar with the literature on field experimentation in agriculture from Germany, Denmark and Britain, as he demonstrated in an article in 1911. The main message of that article was that non-mathematicians had to inform themselves about the mathematical interpretation of experimental results.[64] Moreover, Hudig criticised the way experiments were performed by the officials of the Extension Service. His main target was the habit of the extensionists to combine experiments from different locations and draw conclusions based on calculated averages of these experiments. The idea behind this practice was that the effect of a certain treatment is known better when applied to different locations than on a single field. According to Hudig that was common practice in Germany as well as in Holland, but a wrong practice. To illustrate his argument he used an official report of the Directorate of Agriculture, the office in charge of the Extension Service, containing the results of experiments with fertiliser application to potatoes on sandy soils in the northern Netherlands. Hudig stressed that such experiments give little information on the effect of the fertiliser. "When we emphasise that the report says nothing about the type of sandy soils, no details are given about the kind of fertiliser, nothing is explained about previous fertilisation, nothing about rainfall (...) and still the average is calculated then people will agree with me that the result of these calculations cannot engender much confidence."[65] Besides questioning the experiments as such, Hudig warned that chemical companies use such shaky figures to recommend their products and he ends with the warning: "Differences do not disappear by average-calculation."[66]

The agricultural consultant who performed the experiments, A. Rauwerda, was not very pleased with the criticism, although he agrees with Hudig that it is not easy to draw conclusions from field experiments. But, Rauwerda wondered, "does the practising farmer have to wait before scattering Chile saltpetre or ammonium sulphate until science has solved this problem?"[67] As a consultant he felt "morally obliged" to inform farmers about results of experiments, even if the experiments are not entirely perfect. Rauwerda admitted that the number of experiments was rather small, but Hudig's conclusion that differences do not disappear with calculating averages was received with mockery. Rauwerda drew a comparison

[63] E., "Ir. J. Hudig, Hoogleraar in de scheikunde en bemmestingsleer", 45-46.

[64] Hudig, "Betrouwbaarheid van landbouwkundige proeven", 543-544.

[65] Hudig, "Nog eens de beteekenis", 356.

[66] Ibid., 357.

[67] Rauwerda, "Wetenschappelijk onderzoek en voorlichting", 19.

between his calculations and that of life insurance companies. In his eyes insurance companies do the very same thing, determining the premium on the average age of humans. But, he continued, according to Hudig "such a life insurance then is entirely unscientific rubbish."[68] Hudig's reply was crushing. He patiently calculated how several elements in Rauwerda's experiments influenced the results. He then repeated his conclusion that averages only disguise differences and adds that Rauwerda's example of life insurance is a rather unfortunate choice. "Would we make a true comparison, than I would ask if there is any insurance company that insures a 31 year old man, based on a life expectance calculated from the lifetime of Dutchmen, Turks, Indians, Papuans, Hottentots, Eskimos, Russians and so forth, up to a number of 46 individuals, from whom it is unknown if they died of any disease or not."[69] As to Rauwerda's distinction between the needs of practice and the requirements of scientific precision he remarked that no one forces Rauwerda to draw loose conclusions. "Practice is not favoured by wrong calculations, but benefits more from the plain acknowledgement that the data obtained were inadequate."[70] The editors of the journal put a sentence under Hudig's article saying that they consider the discussion closed.

These characters and several of their arguments will return later on in the story. The original point Hudig made, that mathematical analysis of experimental results is an internationally rapidly developing field of great importance for Dutch agricultural science, was taken up by the board of the Agricultural School in Wageningen. In search for a new mathematics teacher they asked M.J. van Uven (1878-1959) to occupy the position. The mathematics course at the school in Wageningen was mainly to inform students about the principles of land surveying. Van Uven was familiar with analytic geometry, a skill he acquired in combination with probability calculus in the period he worked with the astronomy professor J.C. Kapteyn at the University of Groningen. Lectures in statistics were very important for Wageningen students, according to Van Uven in his inaugural speech. "Wherever it should be analysed, to what laws a large set of living individuals are subjected, for example entire fields with a crop, entire generations of animals and plants, where problems like heredity and breeding are to be solved, it is statistics that, by combining the results of observation, will contribute to find a causal connection. (...). It is therefore advisable, not to say necessary, that particularly agricultural education is supplemented with a special course in probability calculation and statistics."[71] Van Uven would offer such a course to Wageningen students until 1950. With a professor teaching the basics of mathematical statistics,

[68] Ibid., 20.

[69] Hudig, "Wetenschappelijk onderzoek", 109.

[70] Ibid.

[71] Van Uven, *Uiterste strengheid,* 20.

however, the problems agricultural consultants and researchers faced when doing their experiments did not all of a sudden disappear.

### Organising experiments

The emergence of inferential statistics as an international scientific discipline covers a period of about fifty years, beginning at the end of the nineteenth century with the field more or less established by the end of the Second World War. Besides a growing body of mathematical tools and formulations that could be applied to a wide area of topics, mathematical statistics comprised special laboratories and journals, the first of which were founded in Britain, the Galton Laboratory and the journal Biometrika.[72] The combined development of mathematics and its organisational embedding is something that also characterised the introduction of field experimentation in agricultural science in the Netherlands and its colonies. Where the importance of mathematics for field experimentation in agriculture was anticipated with the appointment of Van Uven as a mathematics professor at the Wageningen School, the debate about organising field experiments was certainly not over.

A recurrent element in the discussions is the call for a centre for field experimentation. Hudig for example concluded his article in 1913 with the question: "When will the Netherlands have an institute - a sort of experimental farm - to conduct exact experiments of a general nature that will inform the practical farmer; an institute that will operate and function next to the current local organisation of experiment fields ?"[73] Nine years later at the annual *Landhuishoudkundig Congres* a plea was made for a central commission to coordinate field experiments. The main problem according to the presenter, J.D. Koeslag, was the lack of unity in the implementation of field experiments. "Until now the agricultural consultant operated completely autonomously in his area."[74] It took another nine years before a Commission for the Arrangement for Agricultural Experiments was installed. The commission, with Koeslag among its members, set up a manual for field experiments, that also became the first issue of a bulletin for the extension service.[75] Again the importance of planning and co-ordination of experiments was stressed. "To be sure, co-operation implies a certain loss of autonomy, but each researcher has to realise that this is inevitable and that co-operation will lift the work to a higher level."[76] The discussions on the reorganisation plans however

[72] Gigerenzer, *Empire of chance*, 117.

[73] Hudig, "Wetenschappelijk onderzoek", 109.

[74] Koeslag, "Proefveldwezen in Nederland", 42.

[75] Regelingscommissie, "Handleiding voor veldproeven."

[76] Ibid., 9.

show that the main concern of the consultants was not autonomy as such, but the connection that had to be established with agricultural practice.

In the presentation on the Landhuishoudkundig Congres in 1922 Koeslag made a distinction between the traditional way of conducting experiments that had only a demonstrative value, and the new scientific methods of experimenting, primarily characterised by the use of parallel plots. According to Koeslag, demonstration fields will gradually become redundant to be replaced by experimental fields. In the discussion following his presentation several agricultural consultants pointed at the value of demonstration fields. One of these consultants we met before, A. Rauwerda. Along similar lines to his reply to Hudig, he remarked that practice cannot always wait on science in deciding the value of a certain intervention. Besides, Rauwerda stressed the value of demonstration fields to help farmers get an impression of what is going on. "Now parallel plots make it very difficult, both for the theoretician and the practitioner, to get an impression of a certain factor. (...) The practitioner does not bother about data of experiments, but judges on the impressions he receives from a certain experiment field."[77] Rauwerda was supported in his point by other consultants who stressed that many of the figures from scientific experiments are hardly read by farmers. J.C. Dorst, later the professor in plant breeding, took an intermediate position. He suggested to train special consultants who can understand the statistical data and also have the skill to make assessments in the field. According to Dorst the Institute for Plant Breeding already employed such persons.[78] The suggestion was not taken up by the Extension Service or the later commission that made the manual for field experimentation. But neither did demonstration fields entirely disappear as Koeslag predicted. The commission that reorganised field experiments in fact distinguished four types of experiments. Demonstrations for clear observable differences, observations for things like susceptibility to diseases, orientation experiments to determine what factors to test more precisely, experiments where yield was the decisive element, and institute-experiments not suitable for the field.[79] The manual is very detailed on all the steps to be taken in setting up the different experiments.

Researchers and agricultural policy makers realised that the development of probability calculus and experimental design required a better organisation of field experimentation. Agricultural consultants opposed a biased emphasis on scientific arguments, and pointed to the needs of practice. Despite the opposition, the Agricultural Extension Service was reorganised in such way that field experimentation was centrally coordinated and results of the experiments centrally processed. The data processing was done by the Central Institute of Agricultural

[77] Koeslag, "Het Proefveldwezen in Nederland."

[78] Ibid.

[79] Regelingscommissie, "Handleiding voor veldproeven."

Research (*Centraal Instituut Landbouwkundig Onderzoek*, CILO) set up in 1939 in Wageningen. A similar organisation was implemented in the Dutch East Indies in the late 1920s. Major reorganisations of the different branches of the colonial Department of Agriculture resulted in a central office for agricultural affairs that coordinated field experiments. The organisation was set up in such way that each agricultural consultant had to hand in a proposal of the experiments to be conducted in their area. If the proposal was approved the extension workers received standard formula where all necessary details about the experiment had to be filled in. When the experiment was finished these forms were sent to the central office in *Buitenzorg* where results were calculated and interpreted.[80] Like in the Netherlands, the autonomy of the agricultural consultant, meaning his relation with agricultural practice, was considered important. "With this arrangement the consultant himself keeps the initiative and responsibility for the experiments, which certainly will increase his interest, while the experiment station by its individual contact with the agricultural consultant is entirely informed of the conducted experiments."[81] The quote is taken from the doctoral thesis of J.G. Ossewaarde, supervised by J.E. van der Stok and M.J. van Uven and defended in 1931. The thesis gives a detailed overview of the experiments set up in the Dutch East Indies, including the mathematical processing of the results. The thesis makes clear that these issues gradually established on agricultural science.

The experiments described by Ossewaarde primarily related to attempts by the colonial Department of Agriculture to improve indigenous rice cultivation. One of the strategies for rice improvement was the introduction of improved rice varieties, as described in the previous chapter. In order to analyse the results of the field trials the agricultural research institute appointed in 1932 S.H. Justesen. Sten Holch Justesen graduated in 1931 in Wageningen. The same year the colonial government sent him for three months to Rothamstead, England, to learn more about statistics from R.A. Fisher and another three months to Königsberg, Germany, to do the same with E.A. Mitserlich. Justesen worked as a statistician in rice research until the Second World War. After the war he worked for several research institutes before he was selected by a senate commission to become lecturer in the technique of field experimentation (*proefveldtechniek*) in Wageningen in 1952. From the three candidates for the position there were two university mathematicians with doctorates and Justesen, who never wrote a dissertation, but the commission preferred him for his experience in agricultural research.[82] With the appointment of Justesen statistical testing in general and field experimentation in particular had become a course element in the Wageningen education programme alongside general statistics. This can be considered the

[80] Ossewaarde, *Het proefveldonderzoek bij de rijstcultuur op Java*, 33-37.

[81] Ibid., 36.

[82] *Archive Lh*, 2250.

final step in the process of introducing a mathematically grounded structure of field experimentation into the various Dutch institutes and of agricultural scientific services.

## Mathematical modelling

The last case of numerical abstraction in agricultural science emerged in the same decade where the previous story ended, the 1950s. In those years a small number of agricultural scientists in the Netherlands started to look at agricultural issues, mainly plant-physiological questions, from a linear-mathematical perspective. In 1968 the work was rewarded with a chair named Theoretical Crop Production (*Theoretische Teeltkunde*). Based on this chair a research tradition became established that nowadays is labelled Theoretical Production Ecology. The name issue is not entirely trivial, as will be demonstrated further on, but for matters of convenience the field will be mostly designated by the abbreviation of Theoretical Crop Production, TCP, or in the active form as crop growth modelling. The mathematical approach in TCP is not stochastic but linear. Nevertheless, the discipline is closely related to the field of mathematical statistics as applied in field experimentation, and the following story contains various instances of that connection. The prefix "theoretical" in the name of the discipline refers to abstract notions of complicated and dynamic processes in the practice of crop production and ecosystems. Moreover, "theoretical" also designates an abstraction from practice on the experimental level. Crop growth modellers analyse and experiment primarily through simulation models of crop growth run on computers. However, real plants, ecosystems and agricultural practice are not entirely absent. All crop growth models have to be calibrated and validated, requiring all sorts of data, among others those acquired from field experiments. Secondly, representatives of TCP stand out for advocating clearly and openly the potential and relevance of their work for improving agricultural practice on a regional, national and even international scale.

Before starting the analysis of TCP some words must be said about the scope of the discipline. Mathematical modelling of biological phenomena is certainly not a Dutch invention and neither confined to the domain of agriculture. Although the emergence of mathematical modelling in related disciplines and examples from other countries are included, the analysis of crop growth modelling is restricted to the Dutch version embedded in the research institutes and the Agricultural College in Wageningen. This demarcation leads the story to the life and work of a pioneer figure in the field of crop growth modelling, C.T. de Wit (1924-1993). Cornelus Teunis de Wit was appointed as an extraordinary professor in Theoretical Crop Production in 1968 and remained in that position until his retirement in 1989. The Laboratory of Theoretical Production Ecology that resulted from his chair nowadays contains three chairs, all occupied by PhD students of C.T. de Wit. As will become clear, Theoretical Crop Production in the Netherlands originated in the work of De Wit, combining several areas of science that each originated long before he was born.

**Nutrients, growth and competition**

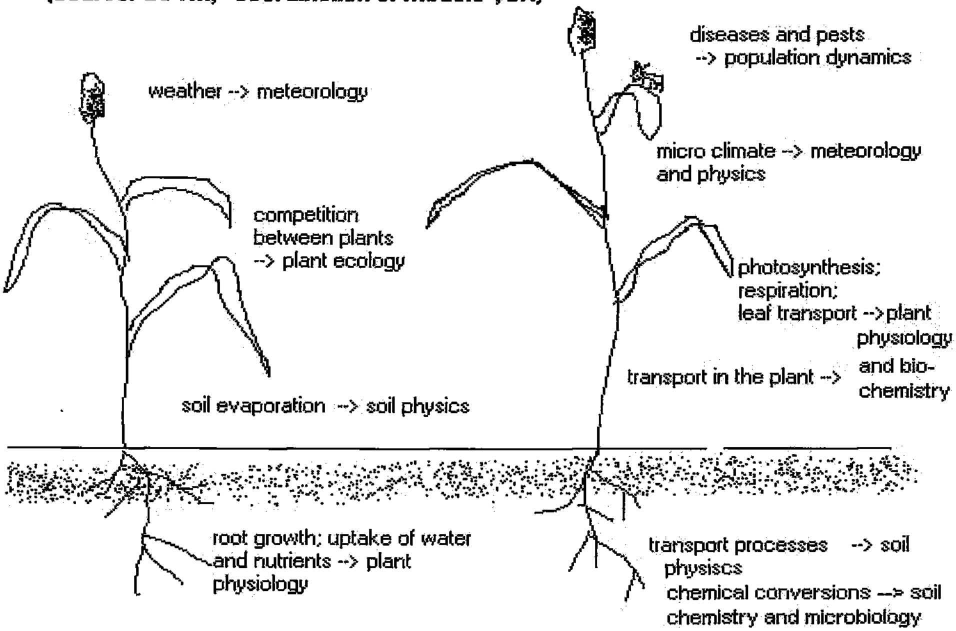
Theoretical production ecology emerged out of several intellectual programmes in both agriculture and biology. The common element is a perception of plant growth in physical terms, preferably laws that can be expressed in mathematical equations. Such use of law-like statements can already be traced in the work of Justus von Liebig (1803-1873). A particular law he formulated, and that for long dominated the perception of plant growth, was the law of the minimum, also referred to as the limiting-factor paradigm. This law states that plant growth is constrained only by a single resource whose availability is so low that it solely inhibits greater growth. The corresponding mathematical equation results in a curve that levels off at a point where further growth is constrained by the minimum resource. The critical contribution von Liebig made to organic chemistry was to distinguish between minerals that were actually present in plants and those that are necessary for plants to grow. His emphasis on essential nutrients and possible substitutes means that he had a theory that allowed for hypotheses and experiments.[83] With the advance of field experimentation, testing all sorts of organic and artificial fertilisers in relation to a wide range of crops, new laws were formulated that allegedly describe plant-nutrient interaction in a more appropriate way, although Von Liebig's law remained a source for explanation. What counts for the emergence of TCP is the practice of using law-like statements that can be expressed in mathematical equations for describing the interaction between plants and nutrients.

A second element in agricultural science that formed a source for the emergence of Theoretical Crop Production is plant physiology and experimental botany. Similar to organic chemistry the emergence of this scientific field brings us back to mid-nineteenth century Germany where the anatomical structures, development stages and internal dynamics of plants were studied.[84] A pioneer figure in this development was Julius Sachs, inspired by the general theory of natural evolution of Charles Darwin. During the late nineteenth century experimental botany spread over Europe and its overseas territories. In the Netherlands and its colonies the main advocates and practitioners of experimental botany were the biology professors Hugo de Vries, who worked in Germany with Sachs, Frits Went, student of Hugo de Vries and M. Treub, director of the Botanic Garden on Java. A graduate of Went, A.H. Blaauw became professor in plant

[83] Krohn and Schäfer, "The origens and structure", 27-52.

[84] Cittadino, *Nature as the laboratory.*

**Figure 1: Processes ans disciplines covered by grop growth models.**
**(Source: De Wit, "Coordination of models", 27.)**




physiology in Wageningen in 1918 where he continued his work on light-growth responses of plants.[85] Although Blaauw was the only professor explicitly commissioned with plant physiology, several other professors and their research staff worked on the issue as well. In chapter five we were introduced to the physiological work done at the Institute for Plant Breeding where the heredity factors in root development were studied by A.E.H.R. Boonstra.

A particular kind of physiological research conducted at various agricultural research institutes was so-called growth rhythm research. With hindsight, growth rhythm research can be considered an early form of crop growth modelling, although the researchers certainly did not put it in those terms. "Growth rhythm is understood as a series of successive phenomena of life, that alternate with each other during plant development in a stereotypic way. This rhythm, although determined by hereditary characters, highly depends on the external environment, especially the climatic factors temperature and light."[86] The agricultural researcher who wrote this, Willem Feekes (1907-1979), spent most of his research studying

[85] Faasse, *Experiments in growth.*

[86] Feekes, "De Tarwe en haar milieu", 552.

wheat plants. His map-like representations of the growth rhythm of wheat became an international standard in wheat research for years.[87] The elements that Feekes' model and the later crop growth models of TCP have in common is a step-wise interpretation of plant physiology on a time-scale. A second common feature is the abstraction of these stages in a numerical representation. What makes Feekes' model different from the crop growth models developed from the 1960s is that it is a static representation of a single plant.

A third element in Theoretical Crop Production stems from ecology, more specifically population ecology. Population ecology originated in the late nineteenth century and stood very close to population genetics. In the early twentieth century the possibilities of a mathematical representation of populations, predation and competition were explored. However, it was not the biologists who introduced mathematical models for ecological phenomena, but mathematicians with a background in physics or demography. The result of these initiatives was an ongoing love-hate relationship between mathematicians and ecologists quarrelling over the question whether heterogeneous and unpredictable nature can be caught in mathematical formula that imply regularity and prediction.[88] Between the 1940s and 1960s the mathematical approach to ecology gradually became established as an accepted, though not uncontested, way of approaching ecological questions. The main element picked up by the Wageningen researchers from this field in the 1950s and 1960s was the concept of competition.[89] Competition is crucial in the difference between stochastic models and crop growth simulation models. Stochastic models treat a crop merely as a large set of individual plants. The statistical model is a numerical abstraction of that large set of individual plants. Crop growth simulation models however consider a crop as a system with relevant functional relations between individual plants that can be represented in mathematical formula and simulated in models. As figure 1 makes clear there are more processes and disciplines that have relevance for crop growth modelling, each of them with its own background and peculiarities. The core of the TCP discipline, however, consists of the three elements as briefly sketched above. What the picture does not display is the contribution of something that is perhaps as crucial to crop growth modellers as all other study areas together, namely computers.

### Digital machines

In an overview article on the 'school of de Wit', published by several crop modellers, the origin of the discipline is set at the moment when computers "had

[87] Gooding and Davies, *Wheat production and utilization.*

[88] Kingsland, *Modelling nature.*

[89] De Wit, *On competition.*

evolved sufficiently to allow and even to stimulate attempts to synthesize detailed knowledge on plant physiological processes (...)."[90] Putting the emergence of TCP/TPE on a par with the emergence of the computer shows the value that crop modellers attribute to digital computation machines. But in the rest of the overview from which the quote is taken the development of computers does not receive any further attention. This is somewhat surprising as the differences between the computers of the late 1960s and those of the early 1990s are huge. More important, however, is that the use of computers for crop growth simulation models determines to a large extent the sort of information that can be entered into simulation models and the information that can be retrieved from them. Therefore a short history of computers and the way digital crop growth simulation models function is important.

The history of computers in the Netherlands brings us back to the Central Bureau of Statistics in the Netherlands, the *CBS*. The *CBS* was in 1916 the first organisation in the Netherlands to use a punch card system for registration, sorting and counting of information. The machine was developed by H. Hollerith in the USA for the national census of 1890. Hollerith owned a small company that was incorporated in 1911 in the Computing-Tabulating-Recording Corporation (CTR) that changed its name in 1924 to International Business Machines Corporation (IBM).[91] From the late 1930s punch machines were connected to other office machines, like calculators and typewriters and electronic components were inserted. Mathematicians, primarily interested in the computing capacity of calculators, kept track of these developments and from the early 1950s computers evolved as devices for both calculation and data processing. The development of the computer was boosted by the Second World War, but in the Netherlands the military was not strongly involved in its development. It was primarily the Mathematical Centre in Amsterdam where in 1949 the ARRA, *Automatische Relais Rekenmachine Amsterdam*, was build. Other Dutch organisations pioneering in that area were the state Post, Telephone and Telegraph service (PTT) and the Philips company in Eindhoven. A major improvement was realised at the end of the 1950s when transistors replaced tubes. These transistorised computers were the so-called second generation computers. The third generation computers came halfway through the 1960s, distinguished by the use of 'integrated circuits' or chips that could do the same work as a number of transistors, making the computers, smaller, faster and cheaper. The smaller-faster-cheaper development was repeated at a rapid pace from the 1970s.[92]

The development of computers in the academic context in Wageningen was also a combination of administrative automation and mathematical interests. Mid

[90] Bouman, "The 'School of de Wit'", 171.

[91] Van den Ende, " Kantoor en informatietechnologie", 250.

[92] Ibid.

1960s a computation centre was added to the university bureau and it became a separate office department in 1971. The Ministry of Agriculture insisted on access to the university computing facilities by the research institutes and agricultural schools, soon resulting in overload on computing capacity. From mid 1970s the facilities of the computation centre were renewed and enlarged several times. In 1988 the computation centre was merged in the Department of Information Facilities and Data Communication.[93]

The origin and development of digital computation machines is not merely of contextual relevance for the activity of crop growth modelling. How crop growth models function is in fact similar to the working of the early punch-card machines. Punch machines were able to sort cards based on the location of the punched holes on the cards. In the early years the totalling of the information was performed by tabulators, but through connecting the punch machines to calculators, different kinds of computations could be made. The basic principle of these machines is that information packages were sorted and transformed by computation into new information packages. Crop growth models work in a similar fashion. The information packages are fixed entities for a certain state of a crop, like the amount of carbohydrates. A process that influences plant growth is, for example, photosynthesis, a chemical reaction that can be expressed in an equation. The rate at which photosynthesis occurs is dependent on the amount of carbohydrates, and so is growth rate. "The fact that rates are not mutually dependent, but depend on the state of the system enables a sorting routine to be introduced for the equations that describe the system. Starting from the known state of the system (...) the equations are sorted in computational order. Then each rate is calculated independently of the others and then all rates are realized over a small time interval. In this way, the program is executed in a semi-parallel fashion."[94] This perception of crop growth allowed the modellers with a relatively small set of equations to process an enormous amount of data. Moreover, "semi-parallel fashion" means that different processes of crop growth could be combined. As computers, through the years, became smaller, faster and cheaper crop modellers could increase the number and complexity of equations, and process more data in a more sophisticated way.

[93] Faber, *Geschiedenis III*, 74-75.

[94] De Wit, "Dynamic concepts in biology", 19.

### A modelled chair

The synthesis of the main disciplines and developments described above into Theoretical Crop Production, as developed in the Netherlands, was for the major part the work of C.T de Wit. During and after his study at the Agricultural College in Wageningen De Wit familiarised himself with plant physiology, agricultural chemistry, ecology and physics.

Cornelis Teunis de Wit was born in 1924 and studied in Wageningen, following the study track arable crops and pastures in the programme Dutch Agriculture. During his study he worked on plant-physiology at the Institute for Plant Breeding, supervised by Boonstra, and after graduation in 1950 he was employed at the same institute. At the Institute for plant Breeding he worked on his doctoral thesis applying physical models to express the uptake-yield relation for different methods of fertiliser application.[95] His supervisor was W.R. van Wijk, professor in physics, meteorology and climatology, the co-promotor A.C. Schuffelen, professor in agricultural chemistry. After he acquired his PhD De Wit was employed by the Ministry of National Planning of Burma as advisor on soil research from 1954 to 1956. In that year he returned to the Netherlands where he acquired a job at the Institute for Biology and Chemistry, IBS. At this institute he further developed his knowledge on photosynthesis and competition between plants in agro-ecosystems.[96] The common element in all his work was a mathematical-physical approach to the processes he studied and in the 1960s the idea arose to create a chair in this new field of agricultural science.

In January 1966 two professors in arable crops, M.L. 't Hart and G.J. Vervelde, and one professor in soil chemistry, G.H. Bolt, wrote a letter to the university board in which they recommended De Wit for a professorship in what they called "integration issues". The university managers replied by asking what these integration issues were.[97] 't Hart explained that the starting point was the work of De Wit himself, namely "the integration of knowledge from the fields of climatology, plant-physiology, chemistry and physics in studying plant production."[98] He admitted that integration issues was maybe a bit too vague a designation, and suggested "issues of plant production processes" or "agro-climatology as a basis for planned production" as other options. The board was not unwilling and assigned a senate commission to make arrangements for a new chair in this field. One of the leading professors in the commission was L.C.A. Corsten, professor in mathematical statistics. Corsten proposed two other names for the chair, "model studies for plant growth" and "theoretical biology". In Februari 1967 the final report of the commission appeared and the name of the chair in that

[95] De Wit, *A physical theory on placement of fertilizers.*

[96] Rabinge, "Professor Cornelis Teunis de Wit." Van der Haar, *Geschiedenis II*, 305.

[97] *Archive* LUW.

[98] Ibid.

report was "applied mathematical biology".[99] After the senate and the minister accepted the report, the commission received the assignment to look for a proper candidate. As de Wit was the envisioned candidate all the commission did was send letters to relevant faculties and departments of other universities with the question what they thought of De Wit, and if they knew a better candidate. Some university departments replied that they never had heard of de Wit, others wondered why they were sent such a letter as the chair seemed to be designed to fit only the profile of De Wit, but no serious objections or other candidates came up.

The preparations of the chair make clear that the approach of a mathematical-physical interpretation and its field of application, crop growth was a relatively unknown discipline, that appeared rather difficult to pin down in a name. It was in the end C.T. de Wit himself who, in a memorandum sent to the senate commission in September 1967, proposed the name Theoretical Crop Production. "In analogy with the labels 'theoretical physics' and 'experimental physics' it seems that the name 'theoretical crop production' is a proper one."[100] De Wit, however, was not entirely sure either and mentioned a second option, "agricultural dynamics". In October 1967 the senate commission advised the university management to appoint De Wit as professor in Theoretical Crop Production and a year later De Wit gave his inaugural lecture. In this lecture he further spun out the analogy with physics.

### Plant or machine

The use of physical models allowed researchers to calculate all kind of balances and quantities in a way that was much faster and precise than by data collection through field experiments. Theorising, extrapolating and integrating data, however, was not the only objective of the crop growth modellers. Almost every publication that deals with the scope and aim of the discipline relates crop growth models to possible or actual applications in agricultural practice. In the first decades these were mainly possible applications, combined with expressions of optimism and high expectations. From the 1980s contributions also describe experiments in applying crop growth models to certain agricultural practices.

The optimism in the early years of TCP about the application of physical models to agricultural processes was based on the use of models in applied physics. In his inaugural lecture C.T. de Wit emphasised the practical application for which models are indispensable. "Indispensable because even in those cases where the principles of phenomena are fully known, the capacity of human reasoning is too

[99] Ibid.

[100] Ibid.

restricted to work out all practical useful results."[101] De Wit continued to expect that crop growth models would have a similar impact on agriculture as hydrodynamic and aerodynamic models had had on the design and construction of hydraulic works, ships, aeroplanes and cars. Such comparisons were rather common in the 1960s and 1970s. In the year De Wit was installed as professor in Wageningen, an Australian researcher, C.M. Donald, discussed the use of crop models in plant breeding. In Donald's 1968 article the traditional forms of plant breeding are considered as being hindered by a lack of knowledge of the underlying physiological processes. Physical crop models, or plant ideotypes, as he calls them, are considered a compelling and promising option to make a big leap forward in plant breeding. "It is the familiar approach in aircraft production, building construction and instrument design, and its validity for these physical purposes is generally accepted."[102] Donald discussed several objections against to use of models in plant breeding, but waved them all aside. "While the weight of these arguments and reservations is recognised, they are believed not to invalidate the proposition that cereal models of likely value can be designed and bred at the present time. (...) The ideotype [...] may prove an imperfect image. Yet the design, breeding, testing and exploitation of plant ideotypes is a logical step towards new levels of yield and should be pursued with imagination. Eventually most plant breeding may be based on ideotypes."[103]

The promises and expectations about the role of physical models of crops in agricultural research and applications in practice were not always that optimistic. One of De Wit's students, H. van Keulen, stated in 1976 that because of these limitations "[m]odels of biological systems are [...] often not more than a subjective expression of our opinion about its structure and behaviour."[104] In the same volume De Wit did not beat about the bush either and called the models, as developed up to then, speculative models, and all that he asked for was faith in the enterprise. "The faith in speculative models is strengthened if similar methods of systems analysis applied to repeatable or recurring systems lead to validated models that cannot be falsified."[105] But as the authors admitted, such systems merely exist in physics, and hardly at all in biology. The "faith" comes down to the belief that biological systems can be treated as if they were physical systems. Once the relation is established, agronomists should be able to control the technicalities of agricultural systems. "Fools rush in where wise men fear to tread, and much of the rushing in this field of simulation in biology is done by agronomists, perhaps because they are fools, but may be because they are concerned with systems in

[101] De Wit, *Theorie en Model*, 4.

[102] Donald, "Breeding of crop ideotypes", 387.

[103] Ibid., 388; 401.

[104] Van Keulen, "Evaluation of models", 22.

[105] De Wit and Arnold, "Some speculation on simulation", 9.

which the technical aspects overrule the biological aspects."[106] Donald, Van Keulen, De Wit and other crop growth modellers openly explained to their audience that the application of physical models to biological systems requires imagination, subjective opinions and faith. In the late 1960s and 1970s crop growth models were in a developmental stage, limited by the capacity of computers, the knowledge of physiological processes in plants and the limited amount of data concerning all sorts of variables. However, the modesty, promises and expectations expressed by crop growth modellers must also be understood in relation to the sort of audience they addressed. The kind of knowledge and control the modellers aimed at was the manipulation of crops in various ways. That kind of activity was a terrain occupied by agronomists, plant breeders, chemists and the like, each with their own stock of knowledge and methods. Crop growth modellers had to convince the scientists and practitioners in these fields that the tools they offered were more sophisticated and useful, or at least an interesting addition. From about the late 1970s experiments with crop growth models were applied in agricultural practice.

**Rationalising choice**

The application of crop growth models in agricultural practice works in a similar way as an experiment field. Experiment fields were selected to represent an agricultural region and the experiment looked at the effect of a certain variable on the performance of a crop. Crop growth models are in fact an experiment "field", albeit a digital version of it. The number of variables that could be tested, however, was several at a time. The effects were not calculated through statistical correlation but through linear equations. The larger number of variables the model could handle, and the fact that experiments run on computers, delivered results much faster, and allowed a more specific testing of certain variables. In other words, where agricultural extension, traditionally, could only supply general advises based on field experiments, crop growth models could specify the advice to the level of a single farm at a rapid rate. With the outcome of such runs the farmer could be advised what to do. Models, therefore, received names such as Decision Support System for Agrotechnology Transfer, DSSAT. This model was applied in a number of areas in tropical and sub-tropical conditions. Three researchers from Edinburgh who worked with the model explained that it should be able "to predict crop growth and development in situations where real field trial data do not exist."[107] With the model several experiments could be done, like finding out what the best variety for particular circumstances is. Other options were to determine the optimum dosage of fertiliser and water, time of planting and

[106] Ibid., 3.

[107] Thornton, Dent and Basci, "A Framework for crop growth", 330.

long term soil and nutrient effects on yield stability. The researchers pointed out that the major restriction of the model was its limited reach. For example, DSSAT was not able to model diseases, pests, intercropping, and animal-crop interactions. "The biology of small-holders' production systems can thus be represented only partially."[108] Another aspect beyond the capacity of the model was the social and economic context. The model was designed as decision support tool but in the end it is the farmer who has to make the decisions and the modellers stressed that "biological feasibility or superiority of an agricultural technology is no guarantee of its adoption."[109] The researchers concluded that these restrictions are to be worked at, but they also stated that model improvement should not be the ultimate goal. "Some kind of cost-benefit procedure would appear to be necessary for assessing whether it would be better to abandon the model and seek other solutions to the problem, or to modify and adjust the model until results are deemed satisfactory."[110] The assessment of the Edinburgh crop modellers can be considered as a modest position in the application of models. Modest, because the conclusion that a model is not an appropriate tool in agriculture should be considered a serious option.

A more optimist (or imprudent) assessment of the value of crop growth models for support of individual farmers is given by two students of C.T. de Wit, who developed their position by discussing the question how simulation models can sustain farmers in 'tactical decision making'. To emphasise the added value of models they draw a sharp distinction between the way farmers make decisions and what models do. "For many centuries, farmers have relied on practical experience to guide tactical decision making (...). However, in intensive agricultural production systems, where often multiple goals are aimed at, there is a need to better structure the decision-making process and consider explicitly the advantages and disadvantages of alternative decisions in quantitative terms. This requires a form of production that experience cannot provide."[111] Here agriculture is portrayed as a production system growing in complexity over the years in which the producers have not changed the basis for decision making for centuries. In that perspective simulation models come as a blessing. The authors did not discuss the option that in some circumstances a model might not be a very handy tool, although the limitations of models regarding the 'dynamic nature of the environment' are mentioned. As for many crop growth modellers that was a challenge rather then a limitation.

In 1990 a review article appeared balancing the advantages and problems with the application of crop growth models. The author is an Israeli researcher, N.G.

[108] Ibid., 337.

[109] Ibid.

[110] Ibid., 338.

[111] Van Keulen and Penning de Vries, "Farming Under Uncertainty", 141.

Seligman, who concluded that the use of crop growth models is at its best in research and teaching and not in application. "The greater understanding gained from crop modelling [...] does not necessary lead to significant application in the short run."[112] Seligman specifically mentioned the field of plant breeding. "Crop models that can estimate the importance of identifiable plant characteristics for determining long-term yield increase and yield stability should have been able to contribute to defining plant breeding aims, but this has not yet been evident." And he is even more disappointed when it comes to farm management. "There are surprisingly few examples of successful applications, even when models have been specially tailored for use by farmers or extension personnel."[113] Nevertheless, Seligman remained optimistic and asserted that his firm criticism "should not deter the new generation of crop modellers."[114] Apparently, the 1980s did not bring the expected boost in applications of crop growth models in agriculture. The first half the 1990s is judged in a similar way by the authors of the earlier cited overview article of the 'school of De Wit'. The models of the early 1990s are not so accurate that concrete predictions about the performance of crops in real practice can be given. "Therefore the operational use of deterministic models that can handle the even more complex situations that typify actual farming conditions is still a long way off, and poses new challenges for the years ahead."[115] One of the authors of the overview is R. Rabbinge, the successors of C.T. de Wit as head of the department of Theoretical Crop Production, renamed as Theoretical Production Ecology. In a report written for the National Council for Agricultural Research in 1996 about agricultural research in the twenty-first century, Rabbinge shows that the optimism about crop growth modelling has not diminished since the origin of the discipline in the late 1960s. According to Rabbinge all fields of agricultural science dealing with crop production will eventually make use of models. "The strong empirical basis of the agricultural sciences and its trial-and-error character is only replaced in this century by a knowledge- and insight-based influencing and manipulation of the different factors that determine growth and production. Therefore agronomy or agricultural science develops more and more in the direction of production-ecology."[116] This preview of agricultural science in the twenty-first century specifies the main issues mathematical modelling will deal with. Spilling of inputs like fertiliser will be solved by "target-oriented input of production factors".[117] Natural obstacles for plant growth will turn "from liability to asset" as the mutual influencing of positive and negative growth factors will be

[112] Seligman, "The crop model record", 256.

[113] Ibid., 257

[114] Ibid.,258.

[115] Bouman, "The 'School of de Wit'", 189.

[116] Rabbinge, *Ontwikkelingen in wetenschap en technologie*, 8.

[117] Ibid., 10.

manipulated to a positive net result. On a regional scale optimising of production factors will be possible when "geographic, soil and climate factors using new information systems will be directly available for the user."[118] In short, the farmer of the twenty-first century will run his or her farm primarily from behind a computer screen, thanks to the development of mathematical models in agricultural science.

Whether the projections of Rabbinge will come true or not, and whether his expectations are based on correct or false assumptions, is not the issue at stake here. The interesting element of Rabbinge's future vision for the story of this chapter is first of all the tradition of sketching future perspectives and expressing high expectations about the use of modelling in agriculture and agricultural science. Such statements can be found from the early developments of mathematical models in the late 1960s until the last decade of the twentieth century and are primarily a response to the yet limited capacity and application of agronomic models. That is not to say that there has been little progress in the discipline and that models of crop growth and related phenomena are not very useful. The amount of available knowledge about plant growth in combination with the growing capacity of computers to sort data and perform very complex calculations yields new forms of information for which, to use the words of De Wit, the capacity of human reasoning is too restricted. However, De Wit and many others working with crop growth models considered the analytical capacity of their models directly relevant for agricultural practice. In the report discussed, Rabbinge stretches the implications of the use models even further. In his future vision all relevant disciplines for the growth of crops (in other words, agricultural science) will base their views and insights on analyses of mathematical models. The analytical superiority of mathematical models will not only lead to a farming practice where the models permit "target-oriented input of production factors" but also to a new sort of agricultural science, producing new knowledge based on models of agricultural practice instead of agricultural practice as such. If that future vision comes true, agricultural science will have released itself once and for all from the millstone around its neck.

## Conclusion

The expression of natural phenomena in fixed numbers and equations is a widespread and common activity in agricultural science. The three cases analysed in this chapter are probably among the most pronounced examples of the way numerical abstraction is used to get a grip on and gain insight into the objects of study. The emergence of economic statistics in agriculture is rooted in the shared

[118] Ibid., 11.

interest between science and government to know the size and topography of national agriculture. The connection between science and government was most clearly visible in the work of Jan Kops, assigned to compile a national statistics of agriculture since 1806 and professor in land-household studies since 1816. Land-household studies (*landhuishoudkunde*) was the agrarian equivalent of state-household studies (*staathuishoudkunde*), the discipline nowadays known as economics and both studies are rooted in statistics. At the time Kops lectured land-household studies, it comprised statistics-like overviews of Dutch agriculture completed with elements from botany, chemistry and other disciplines. Although the combination of assembling data for the government and working for an academic institute was not exceptional, the two activities gradually separated from about the 1830s. In the 1900s both elements fully settled in the public institutions, agricultural statistics in the Directorate of Agriculture, land-household studies in the State Higher School for Agriculture, Horticulture and Forestry (later the Agricultural College) in Wageningen. Both activities were based on numerical abstraction of the possessions and activities of farmers, traders in agricultural produce, companies processing the farm yields, and so on and so forth. The difficulty of acquiring sensible data from the agrarian economy and turning such data into instruments for governance or scientific statements, is best illustrated by developments in the Dutch East Indies. As in the Netherlands, science and government were involved in the same activity, in this case quantifying the productivity of Javanese rice farmers. The colonial government used the figures to tax the Javanese. Other government employees, mainly working for the Agricultural Extension Service of the colonial Department of Agriculture, developed scientific accounts of indigenous land-householding. With these scientific abstractions, the early colonial agrarian economists demonstrated that Javanese farmers were not as irrational as generally thought, and were open to economic improvement in general and all sorts of technical innovations in particular. These technical innovations were derived from another branch of numerical abstraction, mathematical statistics applied to field experimentation.

Numerical abstraction in field experimentation worked more or less in an opposite direction to economic statistics. Where the latter tried to condense a huge number of facts and processes from a large area in manageable and cogent quantitative statements, inference from field experiments implied processing phenomena from a small plot into solid quantitative figures valid for similar phenomena over a much larger area. The analysis of inferential statistics made in this chapter primarily focused on the implications for the organisation of field experimentation. Field experiments have been conducted by employees of the Extension Service since the 1890s. Apart from the common education of the extension officers there were no mechanisms to harmonise method and implementation. From the 1920s the organisation of the Extension Service was adjusted, introducing a centrally arranged planning and implementation of field experiments. The objections of various extension workers to these reorganisations were interpreted by the higher level management as objections to attacks on the autonomy of the consultants. True or not, the criticism of several agricultural extension workers, also reveals a fear that their contact with farmers and agricultural practice is obscured by the introduction of standard methods. These objections reveal a crucial change in the connection between agricultural science established through standardised field experimentation. Where the transfer of scientific insight into practical advise and technological innovations was for a large part mediated by the interpretations of the extension workers, the new regulations implied that most of the interpretation was provided by the standardised experimentation methodology. In other words, the reductionist accounts from agricultural science were generalised and made valid for specific regions through statistical method rather than through mediation of extension workers. Nevertheless, field experiments could not be performed totally without guidance and interpretation by agricultural experts, who were needed to make all sorts of judgements about the situation in the field in the design and performance of the field experiments. The statistical models used for the design of the experiments and processing of the experiment results had little use without a direct connection to a field situation. This direct linkage between science and practice was further stretched by another area of agricultural science, mathematical modelling.

Linear mathematical programming of biological processes in agriculture, in short crop growth modelling, emerged in Dutch agricultural science in the 1950s and 1960s. The expression of physiological processes in plants and the interaction of plants with their natural environment and other plants could be expressed in complex numerical abstractions with the help of computers. The idea behind crop growth modelling was to replace the probability of stochastic models with the certainty of linear models. In other words, where stochastic models were based on a reduction of fluctuation and taming of chance to a certain acceptable level, linear models were based on an eradication of chance and full control of all processes in crop growth. The basic idea of crop growth models implies a disconnection between the experimental level and agricultural practice. Changes in crop growth are not analysed and tested on the field level, but by changing parameters of the model. In the idealised version as sketched by several representatives of the discipline, inference in agricultural science is no longer dependent on experimentation in the unpredictable circumstances and fuzzy conditions of the field, but on the reliable and clear state of affairs represented by the models. Nevertheless, crop growth models are designed to make a difference in agricultural practice. Application of models to practical situations, however, appeared to encounter the various limitations of the models, reducing their validity and efficacy. Confidence in the benefit of crop models for agriculture and the conviction that models move towards a perfect imitation of agricultural practice, leave an impression that the purpose of numerical abstraction in agricultural science has moved from establishing a proper relation between science and practice, towards establishing a situation where agricultural science operates independently of practice.

# 8

# Conclusion

# Conclusion

The story presented in the previous chapters results from an analysis of a range of scientific activities connected to a range of activities in agriculture and other domains of society, in short, an analysis of agricultural science. The analysis was restricted to agricultural science as it developed on Dutch territory, including former colonies. The overall focus in the analysis has been on the way agricultural scientists, policy makers and others formulated various ways of organising agricultural science and the links between science and practice. What eventuated was a description of views about, debates over, and attempts to realise the desired organisation, as well as a description of three fields of agricultural-scientific activity.

The chapter covering the developments in the nineteenth century made clear that a shared concern for agriculture between the government, scientists and representatives of the agrarian community was the main incentive for the creation of a Dutch school for scientific education and experiment station for agricultural research. The situation on Java during the nineteenth century deviated to the extent that a research institute with a focus on agriculture already existed but a clear representation of Javanese farmer communities or organisations was lacking. Due to this organisational constraint in the colonies debates about a proper relation between science and practice concentrated on agricultural research, whereas in the Netherlands the main issue was proper (scientific) education for the agrarian community.

The chapters dealing with the organisation of agricultural research and scientific education revealed that much of the question what agricultural science is and what it aims at was not determined on grounds of principle but on negotiation and agreements about the organisation of research and education. In the case of education it became clear that two major positions can be distinguished, one advocating an emphasis on research capacities, and a specialised curriculum, the other arguing for a practice-led education programme with a more integrated curriculum. Around the turn of the nineteenth century both positions were more or less equally represented in education but gradually disciplinary specialisation became more prominent than practice-oriented generalisation. This development is reflected in organisational changes at the Agricultural College. Before the 1950s a crucial element in the organisation was the board of professors (before 1918) and senate (after 1918), dividing teaching over broad general study programmes with various options for specialisation. Already in the 1920s and 1930s this format was challenged and in the 1950s the organisation was split up in disciplinary units headed by a professor. In the chapter dealing with the organisation of agricultural research a similar development can be detected. However, in the colonies the development was more or less opposed compared to the mother country. The two positions can be characterised as, on the one hand, favouring a separation between pure (or fundamental) research and applied (or practice) research, and an integration of these categories on the other. Around the turn of the century the position of university graduates at the research and experiment stations in the colonies was defended on the argument that centres of pure science should not be polluted by employing 'men of practice' from the school in Wageningen. Representatives of the school replied by challenging any clear distinction between pure and applied science. Through the 1920s and 1930s the integrative perspective gained ground in the colonial institutes where in the Wageningen institution voices to distinguish between the two became louder. Again there was a clear organisational connection. In the Netherlands research activities by the Wageningen professors were outstripped by the activities at the agricultural research institutes, growing in number and importance from the late 1930s, where in the colonies this extra organisational "layer" of academic research was lacking. Organisational linkages with the government played an important role in these developments as well.

The chapter on the development of plant genetics and plant breeding confirms most of the findings of the previous chapters. In particular, the story about genetics and plant breeding makes clear that alliance building between the scientist-breeders and the Directorate of Agriculture was crucial in acquiring a central position in practice. The Dutch seed sector was structured in negotiations between the government, the breeding institute, breeding companies and farmer organisations. Much of the initiative for this structuring came from scientists in Wageningen. Once these connections were set, the scientist started to distinguish themselves from the more practice-related research activities by organising these activities in separate research institutes. Although the linkages with practice were cut off organisationally, the connection was maintained in focus and issues covered by the research. The chapter on rice breeding in the Dutch colonies shows that a rather well organised agricultural sector with representatives speaking each other's languages in the literal and figurative sense is very different from a situation where such conditions are lacking. Where in the Netherlands farmer organisations and breeding companies were active discussion partners in the organisation and regulation of the seed sector, local farmers, breeders, seed traders or their representatives were hardly involved in similar activities in the Dutch East Indies. Consequently, interaction between science and practice on the social level was mainly dependent of the sensitivity scientists, breeders and extension workers developed for the varying and difficult circumstances of Javanese rice farming. In general the agricultural experts recognised the importance of interaction and participation on the farm level but at the same time initiatives in mechanised rice agriculture show that interaction with the local farm level could also be ignored. The final empirical chapter of this thesis showed how concerted action between administrative hierarchy, scientific institutes and research results in a pattern of organising agricultural practice that is not only confined to plant genetics and breeding, but is inherent in all forms of agricultural science using statistical techniques.

In sum, each chapter reveals how the relation between science and practice was discussed, organised and effected over different periods, in different contexts and related to different issues. Although the design of the thesis is thematic and not chronological, the chapters together tell a story about the development of agricultural science in the Netherlands and its colonies different from the mere sum of the parts. In the following paragraphs these more general lines will be drawn together to arrive at the overall conclusions of this thesis.

**Academic attraction**

Crucial in the development of agricultural science in the Netherlands and its colonies was the initial period in the second half of the nineteenth century when the Dutch government, in fact, created a split between scientific education and higher education. Research and education in agrarian issues at the State Agricultural School had a scientific status, but were not included in the system of higher education. Despite this non-academic status, all sorts of university graduates, many of them holding doctorates, worked as lecturers and researchers in the school and experiment station in Wageningen. The decision of the Dutch government to leave agricultural science out of the higher education system marked the development of agricultural science until present day. Early in the twentieth century the government changed its view and granted professional education on technical, agricultural, economical and veterinary issues academic status. However, the existing professional schools offering scientific education were not allowed to call themselves university, but were named college (*hogeschool)*. Both colleges and universities provided scientific education and were supposed to conduct scientific research. When in the early 1900s the changes in the law on higher education were announced, the school in Wageningen, in cooperation with the Directorate of Agriculture, started to profile itself as an academic institution. The University of Utrecht and the University of Groningen tried to attach the school in Wageningen as an agricultural faculty to their institutions, but without success. The management of the school in Wageningen and the Directorate of Agriculture considered an independent organisation with academic status much more attractive. Perhaps for that reason the idea that agricultural science was second-rate science persisted in the heads of many persons in and outside the Wageningen institution, even although the education law, as well as the university system, had embraced agricultural science. Whatever the exact causes, many activities and decisions in the organisation of agricultural science were motivated by the idea that agricultural science should be more academic. In short, academic attraction continued to influence the Wageningen institution.

Around the turn of the nineteenth and twentieth century the academic standard regarding agricultural science was set by a small group of university representatives with an interest in colonial research and experiment stations. These academics (professors in botany, chemistry and other scholars) considered

Wageningen graduates as unfair competition for positions at the research and experiment institutes in the Dutch East Indies. Therefore they stigmatised the school in Wageningen as unscientific, primarily pointing to the many relations with farming practice that in their view polluted the purity of science. Representatives of the school in Wageningen considered insight in farming practice crucial for agricultural science; innovations would only last when built on the capacities of farmers. Regarding the colonial experiment stations the battle between botanists and agronomists gradually died down and university graduates and Wageningen graduates developed good working relations. The different viewpoints about what agricultural science is and what it should be, was not merely a difference between academic scientists and Wageningen scientists. Debates and conflicts over the organisation of research and education in Wageningen show that different views can be traced among various people formally and informally related to the institution. Looking at overall developments over the period between the 1910s and the 1980s it can be concluded that scientists and officials involved in the organisation of research and education could not resist academic attraction. Regarding education, a broad and practice-oriented interpretation of agricultural science as the guideline for the curriculum was gradually marginalised. Early in the 1980s the approach was only defended by a minority of students and some university lecturers. Emphasis on what was called fundamental science, implying a division of course tracks along disciplinary lines became dominant. More emphasis on fundamental science was also a strong motive in the organisation of research. The research of the Agricultural College was disconnected from the activities of agricultural research institutes and experiment stations. The coordinating role of this fundamental research was taken out of ministerial hands and done by the Agricultural College itself.

Chapters five to seven give a more detailed picture of this process in different areas of agricultural science and what it implied for the relation between science and practice. What the chapters make clear is that the academic attraction certainly did not mean that the linkages with practice were cut off. Connections with research institutes, experiment stations, private companies and agrarian organisations were maintained, based on personal contacts between college staff and representatives outside the academic world. Professors and other staff members of the Agricultural College were able to maintain as many diverse contacts as they wanted. Formally they were independent from any organisation in the agrarian sector or elsewhere. The result of this formal independence in combination with the drive to maintain an academic status was a disturbed or blurred connection between science and practice. The perception of practice among agricultural scientists became more abstract and theorised, and matching scientised practice and 'real' practice often required complicated processes of translation. A prominent example of this scientised practice is the emergence of crop growth modelling, described in chapter seven. In its most hierarchical manifestation scientists simply imposed their ideas of how agriculture should work, like in the example of the mechanised rice polders in the Dutch East Indies in the 1920s and in Surinam in the late 1940s.

In sum, much of the development of Dutch agricultural science is driven by academic attraction. The aim and desire to become a full member of the Dutch academic system inspired the Wageningen institution to arrange its research and education along disciplinary lines. The practice-oriented and integrated approach of agricultural science lost ground in education and in research. In other words, science and practice were hierarchically related. This hierarchy became manifest over various reorganisations. In the 1940s and 1950s the agricultural research institutes were detached from the Agricultural College. What was called 'fundamental research' was stimulated in the research activities of the various college departments, research institutes were considered to conduct 'applied research', and the work of the experiment stations was labelled 'practice research'. The development of agricultural research in the Dutch East Indies makes clear that the existence (or absence) of an academic institute as such was important for the creation of a hierarchical research structure. In the colonies all institutes for agricultural science had the same status, some were bigger and more influential than others, but a clear hierarchical relation was lacking. Contrary to developments in the Netherlands, the call for a differentiation between fundamental and applied research became weaker in the Dutch East Indies. In the education programme academic attraction resulted in an emphasis on disciplinary specialisation and education for scientific research. In the 1960s one of the mechanisms introduced to enable students to specialise in a certain direction was more space for optional courses in the curriculum. Ironically, many students used this space to broaden their curriculum rather than to specialise. Regarding the relation between science and practice academic attraction created a formal independence between the Agricultural College on the one hand and the research institutes, experiment stations and other services for agricultural practice on the other. In representations of research and education the scientific character and profundity of knowledge was stressed, linkages with practice were underexposed, or translated to a scientific level. One of the implications of the formal independence of the Agricultural College was a broadening of the issues and topics covered by professorial chairs and, consequently, study programmes and course tracks within study programmes. This broader coverage certainly did not mean abandoning connections with agricultural practice. The college maintained a large number of departments with a clear focus on agriculture. Moreover, the formal disconnection between the college and other institutes did not imply that contacts and interaction between science and practice gradually died out. An element that stimulated the relation between science and practice concerns formal and informal linkages between the Agricultural College and the Ministry of Agriculture. This means that the 'theory of practice' (to use the term of French social philosopher Pierre Bourdieu) was dominated by bureaucratic rather then scientific concern. The link between science and practice became bureaucratised, rather then being treated as a problem for science.

**Public science and agricultural policies**

The academic attraction that pulled agricultural science away from more practice-oriented research and education institutes suggests a loosening of the connection between science and government policy. Throughout the history of Dutch agricultural science several developments indeed hint at a gradual liberation of state interference. The creation and establishment of Dutch agricultural science in the nineteenth century was by and large a result of government investments in agricultural education and research. Private initiatives in research were most prominent in the Dutch East Indies. The main focus of private agencies in the agrarian sector in nineteenth-century Netherlands was lower-level agricultural education. The established private agricultural schools, however, could only survive with state support, partly as a result of formal requirements on teaching level and course issues, and gradually the Directorate of Agriculture transformed these schools into a public school system. In short, agricultural science was by and large a public sector activity, orchestrated by the colonial Department of Agriculture and the Dutch Directorate (and later Ministry) of Agriculture. Interaction and fine tuning between science and policy was a normal activity throughout the analysed period. That does not mean that science and policy smoothly integrated and never disagreed. An example of a problematic linkage is the relationship between the senate and the board of curators, two typical bodies of the Dutch academic system during the first half of the twentieth century. The board of curators was supposed to function as a sort of buffer between the Agricultural College and the ministerial Directorate of Agriculture. However, the professors viewed the curators more and more as an instrument of the government, creating much administrative hassle. In the university reforms of the 1950s and 1960s these boards were abolished. In the same university reforms several other ties between the government and the academic system were broken or loosened, like ministerial responsibility over the curriculum. These reforms, however, were not specific to the Wageningen institution. What was specific for the Agricultural College was the disconnection between the college and the agricultural research institutes, and the new responsibility over research coordination by the institution itself. These developments together might give the impression that agricultural science gradually freed itself from the ties of government policy. But these formal changes only reveal one side of the story.

In the chapters on wheat breeding, rice breeding and statistics I have pointed out in detail how connections between research, government initiatives, private companies and organisations were set up. In the chapter on the organisation of research a major development that clarifies the position of the government in agricultural science was the establishment of the national organisation for Applied Natural-scientific Research, the TNO organisation. Although the TNO organisation was in itself a government institute, its main incentive was to clear and protect a space where applied research for general and specific purposes in various sectors of the Dutch economy could flourish. Agricultural research was from the start an obvious candidate to be incorporated in the TNO organisation. However, by various moves, the ministerial Directorate of Agriculture managed to keep the research institutes in its own hands. Apparently the responsible officials considered research coordination too important to be taken out of their hands. What remained was a general consultative body, based on a TNO format but operating in close connection with the ministry. Another example on the general level is the development of science related to colonial agriculture. During the period Indonesia gained its independence, the international agenda concerning agriculture was changed from research and development oriented on colonial relations to research and development for international support programmes. Various prominent Dutch scientists and diplomats argued that this offered many opportunities for new linkages between Dutch agricultural science and the new international institutions. However, the established connections in tropical countries were primarily organised through agreements on a departmental level with much attention paid to the remaining colony, Surinam. Apparently, agricultural science feels comfortable with government support, not only financial but also in focus and performance of research activities. Another example of the attractiveness of government support is the move made in the 1930s by private experiment stations in the Dutch East Indies. In response to the international economic crisis, the boards of the stations found shelter in a government organisation, not only supporting the research institutes financially, but also coordinating research tasks, priorities and cooperation. In other words, private stations were willing to allow government officials to interfere in their research strategy in exchange for financial support.

In sum, agricultural science and administrative bodies of the government dealing with agriculture are two allied powers. The ties between the two vary, strings are often elastic, some are cut off deliberately, some may snap, but the many-stringed rope is never completely broken. The bond with the ministry is not the most favoured element to point out when the status of agricultural science is at stake. Too many connections with the outer world blots the academic reputation. At the same time, connections between science and government are considered obvious and are openly acknowledged. For more than a century agricultural science and the Wageningen institution were connected with the directorate and ministry responsible for agriculture. Other academic institutes functioned under the umbrella of the ministry for education and science. Despite the desire to resemble other academies, the Wageningen institution never challenged that special position as it implied all sorts of advantages. Defining science and policy as two allied powers also hints at the hierarchical organisation of agricultural science as discussed in the previous section. The intensity of the interaction between agricultural science and government favours organisational mutuality. Moreover, various examples in this thesis make clear that the authority of science was not always based on superior and exclusive knowledge but needed the authority of the government in order to establish and maintain a central position in agricultural practice. Until present day the final responsibility over agricultural science is in the hands of the Ministry of Agriculture. The ministry controls, facilitates and encourages contacts between the major agro-scientific institutes and agricultural practice. The close relationship between agricultural science and policy does not necessarily mean that the two always agree and never go their own way. The point is that the similarity primarily works on the institutional level. From that perspective the Agricultural College, research institutes and experiment stations on the one hand and the Ministry of Agriculture on the other can be considered as twins, sharing a cognitive closeness based on a common (hierarchical) institutional culture. This brings us back to Douglas' argument about how institutions "think". Science needs hierarchy as a methodological tool (to aggregate or generate reliable results) but it does not have to be organised hierarchically. A feature of Dutch agricultural science is that, seemingly, it feels exposed unless double-wrapped in a bureaucratic as well as scientific blanket of hierarchy. Perhaps herein lie some of its difficulties in coming to terms with the much broader range of issues and societal concerns that are today queuing up behind the word "agriculture".

### Institutional legacies

The story presented in the previous chapters covers different geographical areas, different institutes and different issues. Researchers and other agricultural experts worked in different natural and agricultural conditions but also in different social climates or groups. The social climates encountered in this thesis cover a range of people and groups interested in and committed to agricultural science, its organisation, aims and range. Being interested in agricultural science is a necessary but not sufficient condition to fit a particular group. Social groups have all sorts of peculiarities and mechanisms to recognise or qualify other persons as group members. A simple and straightforward example is given by one of the interviewees who just after graduation was employed by a chemical company to sell artificial fertiliser to plantation owners in the Dutch East Indies. Within a year he quit with the job because, as he explained, he could not meet two crucial conditions to socialise with planters, playing bridge and drinking alcohol, making him rather worthless as a salesman. Such concrete examples are difficult to find in official reports and documents. For pragmatic reasons interviews and personal correspondence are only a minor part of the sources used in this thesis and therefore a detailed sociography of agricultural science is not provided. What can be traced in all the sources analysed over the entire period are some of the effects of group formation in relation to perceptions of what agricultural science is and how it can serve agriculture best.

The two major geographical territories covered in this thesis, the Netherlands and the Dutch East Indies, each had different social environments within which agricultural scientists worked, resulting in different views on agricultural science that crystallised in a different organisational development during the first half of the twentieth century. In the Dutch East Indies a major conflict was whether research for agriculture should be fenced off from interference with administrative matters and agricultural practice or should be integrated. The two opposing groups were roughly divided between university graduates and Wageningen graduates. The most ardent proponents of both positions however did not manage to create a clear organisational divide over the various public and private research institutes, consistent with opposing views. All institutes for agricultural research had more or less the same organisational format and most scientific staff of experiment stations and research institutes were member of the 'society for experiment-station personnel'. Moreover, the Dutch population on Java was relatively small and social interaction rather intense. These social and institutional characteristics favoured the vision that a differentiation of agricultural science into 'fundamental' and 'applied' was not a very good idea. In the Netherlands social conditions favoured an opposite development during the first half of the twentieth century. The regional experiment stations and the college community of the Wageningen institution were more or less two separated social worlds, with the research institutes hanging somewhere in between. Experiment stations had a different assignment, different activities, different staff divisions, no students and clear contacts with the regional farming community. The institutional environment of the Agricultural College in Wageningen was organised as an academic community, with professors and students having very little direct contact with the agrarian sector. As a result, an organisational differentiation between college, research institutes and experiment stations occurred, finalised in the 1950s and 1960s.

Formation and maintenance of social groups mostly entails processes of inclusion and exclusion. Principles and perceptions are both cause and result in such processes, and making predictions about the end result hazardous, as the different developments in the Netherlands and the Dutch East Indies demonstrate. Following the outcome of the previous section the alliance between agricultural science and the government administration dealing with agriculture displays many features of a social solidarity, as conceived by Cultural Theory. The effect is not only visible in good cooperation between representatives from the domains of agricultural science and agricultural policy but also in beliefs and views. In chapter six for example the system of registration and control over crop varieties was initiated by representatives of the Institute for Plant Breeding, supported by the government administration. Although representatives of private seed companies were involved in the process, there were several conflicts between the public and private sector over interpretation and implementation of rules and regulations. Despite these conflicts and whatever the reasons and motivations, all parties were committed to the issue, based on shared social and cultural ties. General cultural factors (being Dutch) and a rather intensively regulated agricultural sector made joining the norm and stepping out the deviant. This was exactly the opposite regarding the seed sector in the Dutch East Indies. When government involvement in rice breeding started (early 1910s), researchers and government officials realised that improvement of plant material had to link with local initiatives and conditions. Because of the complexity of social and natural conditions, the seed sector for rice in the Dutch East Indies was far less formalised than the seed sector in the Netherlands. Although interaction with local seed agencies and farmers was a constant concern for the colonial breeders, such interaction was difficult to formalise because a clear social and cultural ties between the various groups was lacking. Representatives of the colonial government and research institutes were mainly Dutch, seed traders often Chinese, and rice farmers Javanese. In that context an effective regulation of the seed sector and introduction of improved varieties was far more difficult in the colonies than in the Netherlands. Consequently, formal (institutionalised) relations were primarily established between science and government.

As already mentioned in the previous section, the interaction between agricultural science and government policy for agriculture creates similarity in organisational formation. One of the results is that scientific innovation is organised in ways similar to policy implementation in the government, meaning a central institution with a hierarchical relation to local level organisations. When institutions are maintained under similar conditions over the years, lines of reasoning and proposed solutions tend to go in a direction reflecting the institutional "groove". Crucial for the social solidarity between agricultural science and government policy is to have a functional relationship with groups in society, like private companies, farmers and others. This means that the social solidarity between science and government must be extended to relevant social groups. The success of creating such organisational linkages determines the success of the relation between science and practice.

### Science and agriculture diverge

Summarising the previous paragraphs, the three shaping processes of agricultural science in the Netherlands and its colonies are academic attraction, science-government interaction and institutional rigidity. The articulation of Dutch agricultural science in different times and places makes clear that the interaction of these shaping forces can work out differently, even when most persons have a similar educational background. It must be kept in mind that this is often highly dependent on a fourth crucial factor in agricultural science, the natural and material conditions. Differences in climate, vegetation, geomorphology and so on limit the range of directions in which agricultural science can develop. Besides limiting factors, non-human elements also provide stepping stones that partly set out the path agricultural science takes. The combination of these four shaping forces resulted in a different development of agricultural science in the Dutch East Indies and in the Netherlands. In the colonies the rich natural environment, a constant growing season and close interaction between science and government resulted in a flourishing of agricultural science. Moreover, the relative low influence of academic attraction resulted in a rather close connection between science and practice, although social and cultural differences between Dutch experts and local practitioners formed a counterbalance in that respect. The lack of institutional continuity caused by de-colonisation and the resulting breakdown of the science-government interaction implied a gradual disappearance of Dutch institutionalised science for tropical agriculture. In the Netherlands institutional continuity and the interaction between science and government were more stable factors. Academic attraction was much more influential in the Netherlands, resulting in a distorted and blurred connection between science and practice.

The overall conclusion of this thesis is that Dutch agricultural science, perceived as institutionalised activities in scientific research and education, developed from a situation where the interaction between agricultural science and agricultural practice was rather direct and close into a situation where this interaction became differentiated and more remote. A major implication of this development is that the boundaries of agricultural science are moving, demarcating a wider area than before. The institutional differentiation over the Agricultural College, research institutes and experiment stations reflect the emergence of a hierarchical differentiation between more and less fundamental or more and less practice-oriented research. The demarcation of applied and fundamental research, a recurrent issue in agricultural science, is an unsettled question that primarily reflects the institutional differentiation within agricultural science. The term agricultural science itself indicates that science and practice are inseparable, implying that institutional differentiation results in a broader and diverging idea of agricultural science. This process is directly visible in the various new disciplines that were institutionalised from the 1950s at the Agricultural College, resulting not only in the intended enforcement and expansion of the fundamental sciences, but also bringing in new fields and issues to which these sciences adhered. In other words, not only was science stretched, but (agricultural) practice was drawn in this direction as well. Similar to the changes in science, practice changed in both vertical and horizontal dimensions. The growing distance between agricultural science in its most fundamental form and the most applied form meant a definition of agricultural practice on various levels. Horizontally, the issues that are related to the production of food and other agricultural activities expanded over time. This was partly a result of growing scientific insight into connections between, for example, food production and human health, or between chemical inputs and environmental degradation. Partly the issues agricultural science had to take into account were effects of changes in society, like the growing importance of leisure activities in the countryside. This divergence of science and agriculture took place in the same institutional environment. The exceptional position of the Agricultural College in the Dutch higher education system, the institutional connection between agricultural science and the ministerial departments responsible for agriculture, remained unchallenged. Things began to change from the late 1980s, as public concern for environmental issues grew, and food safety scares began to focus a new almost entirely urbanised citizenry's attention to agriculture once more. But that is an unfinished story, largely beyond the scope of this thesis, apart from the postscript below.

# Postscript: some current developments

The period covered by this thesis runs from 1863 to 1986. In the introduction I explained that these years are chosen partly on historical grounds, partly for pragmatic reasons and should not be considered as a fixed beginning and end. In fact, the second opening quote of this thesis originates in the late 1990s, a period in which the Wageningen institution contended with difficulties not unlike those in the late nineteenth century. Furthermore, in the first chapter I made some few remarks about the relevance of a sociological analysis of the history of Dutch agricultural science for current issues and recent developments. What I will do in the final section is further scrutinise some developments from the period after 1986. The guiding question for this part is: what are the major changes in the organisation of agricultural science in the post 1986 period and what can be said about these changes from a long-term perspective as set out in this thesis? By addressing this question I hope to demonstrate that a long-term analysis of the development of agricultural science is relevant for understanding current issues and debates in the agricultural sciences and what the implications are for the relation between science and practice. Besides findings and material used in the previous chapters some extra sources are consulted for this part, mainly policy reports and documents written under the authority of the Ministry of Agriculture or one of the public agricultural organisations. Most of such documents set out lines, and sketch scenarios, that run from a certain point in the (near) past to one or more directions in the (near) future. Although for a complete picture the use of only one type of sources is somewhat dubious, it will serve its purpose for the following pages. The main thing that will be done is to compare the lines and scenarios set out in the policy documents with the lines set out in this thesis. That approach should lead to a satisfactory answer to the question posed above.

### Symptoms of change

There are two reasons why the period after 1986 can be considered as a period of change, perhaps even a turning point in the development of agricultural science in the Netherlands. These reasons are not unexpected events or sudden changes that redirected the course of scientific development, but a further instance of the working of a process already pointed out in the conclusion to the thesis, the divergence of science and practice. As described above, one of the elements of this process was that agricultural issues not only concerned production of food and other products but also interconnected to issues of health, nature conservation and a growing interest in non-agrarian activities in the countryside. As already noted, these changes were partly caused by the growth in scientific knowledge over such relations, as well as being induced by changes in society and public awareness. One of the effects of this development was a reduction in the farming community. The number of people employed in Dutch agriculture (and fisheries) diminished from 243,000 in 1987 to 225,000 in 1994.[1] Over the course of the twentieth century agriculture has turned from the major social-economic activity into a small sector of social and economic life. This reduction is partly a result of changes in science, because scientific and technological innovation increased land-productivity and, at a much greater rate, labour-productivity.[2] In the 1950s and 1960s the government tried to reduce the resulting pressure on labour by opening new farms in the reclaimed land areas, but this policy was stopped at the end of the 1970s. Moreover, there is greater awareness now, that modern agricultural production has all sorts of consequences for human health, and that environmental conditions and the landscape put all sorts of legal and social constraints on farming in the Netherlands. For some farmers these constraints were a reason to look for another job or to move to another country to continue farming. Those who stayed and continued farming had to meet all sorts of new technical and administrative demands, requiring new technological investments and new scientific investigations. In sum, in the 1980s and 1990s structural change became manifest in the field of application of agricultural science. These changes in turn affected the organisation and activities of agricultural science.

The second reason why the post-1986 period can be considered a turning point in the development of agricultural science concerns a change in the policy, organisation and attitude of the Ministry of Agriculture. Between the late 1940s and the 1970s the Ministry developed into a solid defender of the interest of the farming community, interpreted as a steady growth of productivity and production. This objective was embedded in a rigid and primarily hierarchical ministerial organisation. Consequently, voices pointing at some of the harmful effects of intensive manuring, pesticide use or groundwater extraction were mainly ignored when coming from outside the organisation. Similar fears raised by the ministry's own control apparatus were suppressed.[3] Late 1980s and early 1990s a series of incidents involving fraud, cover-up operations and whistle-blowing officials induced a gradual change in ministerial organisation. Moreover, the defensive attitude towards developments and issues that might endanger agricultural production was exchanged for a more open and integrated approach. New policies were developed to help make the agrarian sector more sensitive to and innovative regarding new demands on food production, nature conservation and other issues affecting agricultural production. Not surprisingly, a major input for such changes was expected from agricultural research and education. But agricultural science itself also became subject to the change in ministerial policy and organisation.

[1] CBS.

[2] Van Zanden en Griffiths, *Economische geschiedenis*, 221-223, 265-268.

[3] Van der Kroon, *Ministerie in crisis*. Frauws, *Mest en macht*.

### Changes in research and education

One of the implications of the change in the Higher Education Act in 1986 was a new name for the Agricultural College. The law allowed all colleges (*hogescholen*) to designate themselves as university. For the long-term development of agricultural science this can be considered a symbolic peak in the process of differentiation between fundamental (or pure) and applied (or practice) research. The wish to become a full member of the academic community had come true, and from that point of view it is reasonable to expect the new university would cherish its distinctive position. But what happened, in fact, was an opposite move. During the 1990s a process was set in motion implying an integration of the various layers of agricultural science. At the same time the official connection between agricultural science and practice was cut. This formal connection between science and agricultural was the extension service, managed by the Ministry of Agriculture. In the 1990s the ministry decided to privatise the service, a process stretching over several years. The latest policy report of the Ministry of Agriculture states: "Privatisation of extension will be completed in 2001. (...) From 2001 policy-related extension programmes will be realised by open call for tenders."[4] The effects of this decision worked in two directions. One is that informing farmers and agricultural enterprises about relevant developments in knowledge and technological innovation is no longer considered a major government responsibility. Agribusiness and farmers are supposed to hire in relevant support for innovations from private extension agencies. The other implication of the decision was that the knowledge and technology generating agricultural services lost their formal outlet to the agrarian sector. The agricultural research institutes and departments had to establish a linkage with agricultural practice in another way. This was an anticipated effect, as the research departments and institutes were told they needed to focus more on "steering by demand, the principle of consumer-paid services and a growing interest of clients in exclusivity of generated knowledge."[5] Together with this official demand for client-orientation the various institutes for agricultural science were put in a new umbrella-organisation. In a letter to parliament the minister observed an overlap and lack of programmatic coordination between the various research levels. Therefore, the experiment stations, together with other regional research centres undertaking practice-research (*praktijkonderzoek*), research institutes, and the Agricultural University are brought together in one organisation, renamed in 1998 Wageningen University and Research Centre. "This results in a unique combination of university education and fundamental-, strategic- and practice-oriented research."[6] In other words, the organisational differentiation of experiment

[4] Ministerie van LNV, *Kracht en kwaliteit*, 34.

[5] Van Aartsen, " Kabinetsstandpunt over het advies", 7.

[6] Ministerie van Landbouw, *Kracht en kwaliteit*, 33.

stations, research institutes and academic research, a process set in motion in the 1940s and 1950s, was reversed in the 1990s. Some more details of this process are revealed further down, but first some attention is given to the changes in agricultural education.

The modification of the Higher Education Act in 1986 implied for the Agricultural College more than merely a name change. A major decision, stretching over all fields of education, was to include vocational schools in the academic system. Such schools offered vocational or professional education at a sub-academic level. They already used the prefix 'higher' in their names, like the Higher Agrarian Schools (*Hogere Agrarische Scholen*), but with the inclusion in the higher education system they were given the designation 'college' (*hogeschool*). In short, the higher levels of professional education moved a position upwards in the education system and from 1986 two levels of professional education were part of the higher education system. Similar to the merger of the different levels of agricultural research, the changes in the education system seem to imply a shift from differentiation to integration. Historically, the differentiation in agricultural education stems from the 1910s. In 1912 the lower level education was removed (literally) from Wageningen and set up as an agricultural school in Groningen and a similar school for colonial agriculture in Deventer. Over the twentieth century various other agricultural school were created, similar to the ones in Deventer and Groningen and in 1986 they were all (re)united with the Agricultural University in one system. But the integration was only statutory and not organisational. Despite some initiatives to merge the Agricultural Colleges and the Agricultural University they remained separate institutions. Moreover, the new colleges were not entitled to call their study programmes scientific. The colleges provide higher vocational education (*hoger beroepsonderwijs*) the universities provide scientific education (*wetenschappelijk onderwijs*).

**Table 1: Student numbers over 1987-1999. (Source: CBS.)**

| **Year** | **Students all universities** | | **Students Agricultural University** | | |
|---|---|---|---|---|---|
| | | *growth/decline* | | *growth/decline* | *% of all* |
| 1987 | 180100 | | 6664 | | 3.7 |
| 1991 | 191700 | +6.4% | 5931 | -11% | 3.1 |
| 1995 | 177600 | -7.3% | 4449 | -25% | 2.5 |
| 1999 | 162700 | -8.4% | 3778 | -15% | 2.3 |

Another important change of the 1990s in relation to agricultural education is a serious drop in student numbers. As table 1 shows, the student population of the Agricultural University went down much faster than the national average. Where the Wageningen institution registered about 3.7 percent of the total Dutch student population in 1987 this figure was a mere 2.3 percent in 1999.

Moreover, the Agricultural University lost ground to the agricultural colleges. According to official statistics, student numbers of the various agricultural colleges dropped from over 9,500 in the early 1990s to over 9,100 in 1999.[7] This means a reduction of almost 4 percent, much less than the reduction for the Agricultural University over the same period. Although such figures express rather complex, and often adverse trends and changes, there are things that are very clear from these figures. First of all, there is a clear turning point in the development of student numbers. From the mid-1980s the number of students gradually decreased whereas before that period student numbers showed a steady upward trend. Secondly, where the decrease in student numbers hit all academic institutions, the drop in student intake at Agricultural University was far above average. Whatever the reasons students opted for other universities, it cannot be entirely blamed, as often heard, on the unpopularity of agriculture, as the comparison with the agricultural colleges makes clear. A major effect of the decreasing student numbers at the Agricultural University was a series of reorganisations of the study programmes and curriculum of the Agricultural University.

**Agricultural science united**

Most accounts of the current developments in agricultural science are recorded in reports of the National Council for Agricultural Research, NRLO. As will become clear below, these reports were rather influential for the development of agricultural science in the late 1980s and 1990s, and therefore some things need to be said about the background of the NRLO. As described in chapter three, this council is the offspring of attempts made between the 1930s and 1950s to integrate agricultural research in the national organisation for applied natural-scientific research (*Toegepast Natuurwetenschappelijk Onderzoek*, TNO). Because the Ministry of Agriculture would not give up its tasks and responsibilities in this area, the compromise was a council based in both the ministry and the TNO organisation. Nowadays the ties between the NRLO and the TNO organisation are entirely cut, and the council is the major science policy instrument for the Ministry of Agriculture, producing several reports every year on all sorts of developments related to innovation and knowledge production in the agrarian sector.[8] The picture of NRLO activities from 1986 is rather different from the council's preoccupations in the 1960s and 1970s. The issues covered by the council in the recent past are far less specific and relate primarily to the general organisation of agricultural research and education, including the organisation of the Agricultural University.

[7] CBS.

[8] http://www.agro.nl/nrlo/

What are the directions set out in the reports issued by the NRLO and other documents?

All reports analysed consider the connection between the agrarian sector and the agricultural science institutes crucial for the future of agricultural science. A major problem the reports detect in that connection is that science institutes hardly take notice of the agrarian sector and the changes going on. Several reports state that research divisions have incorporated the major objective of the 1950s (productivity growth) and never adjusted or even discussed that aim. "Little is made explicit of the objectives, tasks and responsibilities in policy, funding and implementation of the technology-policy. This applies specifically to research. (...) Technology-policy is targeted too little on other interest and objectives than agricultural production."[9] Moreover, the (hierarchical) differentiation between fundamental, strategic and applied research is no longer considered appropriate, due to "a melting into one another of the cycles of knowledge generation and innovation."[10] In sum, the policies set out in the 1950s and 1960s and implemented over the 1970s are ready for a major revision. Based on these observations, most reports advise clarifying the objectives of agricultural research, meaning a clearer profiling of the various institutes and a better connection to developments in society. This 'better connection' implies that more attention should be paid to what is going on, but also that there should be public participation because there is "a growing pressure in society to have a voice in modes of production."[11] The report from which these quotations come, is the result of a series of studies on the future of agricultural science in general and the Wageningen institution in particular. As with most policy reports, it makes various recommendations for the future organisation of agricultural science.

A major recommendation is to profile the Agricultural University as an "integrator of knowledge". "This relates not only to integration of scientific and technical disciplines or combining fundamental, strategic and practical approaches, but also to an integrated approach to problem areas, including, for example, their technical, environmental and social aspects."[12] Another recommendation is to define certain fields of attention. Two such fields are sketched. One is labelled "agribusiness and food", being the "entire process of food and non-food production, processing, distribution, sale, consumption and waste disposal, including environmental aspects and land use so far as related to agriculture and the food chain."[13] The other field is titled "green space" (*groene ruimte*) referring to "issues of use, layout and management of the rural area,

[9] Van der Meer, Rutten en Dijkveld Stol, *Technologie in de landbouw*, 143.

[10] NRLO/OCV, *Wageningen in profiel*, 18.

[11] Ibid., 7.

[12] Ibid., 33.

[13] Ibid., 37.

relations between the urban and the rural, and implementation of a variety of functions in rural areas (...)."[14] The two fields of attention are visualised respectively as a vertical and a horizontal axis, crossing at the point of agricultural production. The advice is to focus on one of the fields or a combination of the two. The report appears to have been rather influential in the changes in the agricultural science institutes set in motion in the last two years of the twentieth century.

In 1998 the decision was made to integrate the research institutes (DLO), university and regional experiment stations in one organisation: Wageningen University and Research Centre (Wageningen URC, later shortened to Wageningen UR). "The work field of Wageningen URC can be envisioned schematically as the space spanned by the two main axes: the one comprising the *agro-production* (...). The other main axis relates to the quality, planning and management of the *green space* (...)."[15] The recommendation formulated in the NRLO report to integrate knowledge and expertise is taken up as well. "On the longer term we aim at an *organisational* integration of the activities of DLO, Agricultural University and practice-research (...), in the form of integrated 'knowledge-units'. (...) These knowledge-units will be formed by integrating (parts of) the current research institutes, university departments and experiment stations."[16] The knowledge-units are considered to be the core centres that perform research activities and offer course elements to the teaching programmes. Five such units are proposed, plant science, animal science, agro-technology and food, green space, and gamma-science. The formulated ambition of the new organisation is to become an institution "in the midst of social developments; alert and engaged; in its field belonging to the five highest qualified knowledge institutions in the world; (...) considered by (pre-university) students as a highly-valued academic centre (...)."[17]

In sum, in the second half of the 1990s official advisory boards and councils urged the agricultural science institutes to focus on a specific range of socio-economic activities. Central in these activities is still agricultural production, not as an aim in itself, but as part of a chain or field of related issues and processes. This focus has to result in a clear and competitive profile against other scientific institutes. The advice was taken up by the Ministry of Agriculture, resulting in the launch of a new organisation for agricultural science in 1998. To what extent the recommendations and ideas are implemented, and if and how objectives are to be realised will become clearer in the coming years. In some final paragraphs I will

[14] Ibid., 39.

[15] Wageningen URC, *Strategische visie*, 3.

[16] Ibid., 22.

[17] Ibid., 5.

draw some parallels with developments in earlier periods and try to identify some of the tensions in the new institutional configuration.

### New directions and new tensions

The developments in Dutch agricultural science set out in the second half of the 1990s need to mature before any balanced judgement will be possible. Other major reorganisations of agricultural science in the past took at least fifteen to twenty years to get a clear shape. Yet, from the perspective of the analysis provided in the previous chapters the current developments in the organisation of agricultural science show some remarkable changes compared to directions set out in earlier stages. The most remarkable move is the radical change in the relation between the various units of agricultural research. During the twentieth century the research activities performed at the laboratories and departments of the Agricultural College were gradually detached from the activities at research institutes and experiment stations. This process fits the perception that science should be pure, meaning that decisions about research issues are made autonomously and (consequently) result in fundamental research. Research at the Agricultural College could move in that direction because the values of agriculture and the Ministry of Agriculture hardly ever came into question, and both expanded steadily during the major part of the twentieth century. As a result, the relation between science and practice became fragmented and blurred. Various policy reports, appearing during the 1990s, detected a similar disturbance in the relation between agricultural science and practice. In response to criticism and recommendations, the Ministry of Agriculture launched a major reorganisation of agricultural science, resulting in an integration of the various institutes. What can be questioned, however, is whether the integration also implies a clarification and reconciliation in the relation between science and practice. One of the points set out in this thesis is that the blurring of the science-practice relation does not mean that ideas and perceptions of practice are absent in the higher levels and more abstract operations of agricultural science. Where agricultural science has lost a direct or formal linkage with practice, new definitions and perceptions of agricultural practice appear, based on the technological innovations and knowledge produced in the research divisions. In short, abstract science creates its own abstract practice. Consequently, it is possible that the research units in the new organisation together move in a direction of abstract knowledge production, primarily aimed at the international scientific community rather than looking for an integration between science and (agricultural) practice. But another option is equally possible. Abstract models and images, whether computer-based or in people's heads, can have various modes of complexity and scale. As anthropological research has shown, even uneducated farmers make abstractions and model their fields to certain views and expectations. In that light the research of Wageningen UR might as well focus on integration of models and experiences on various levels of complexity and scale, rather than imposing the most technologically advanced model. In short, an organisational integration of "fundamental-, strategic- and practice-research" leaves open what the effect is for the relation between science and practice.

The decision to integrate the various levels of agricultural science is also remarkable when we look at education. The academic attraction detected in the development of agricultural science is for a large part the result of the position of the Wageningen institution in the system of higher education. In the 1910s the connection with higher education was formally established but at the level of the curriculum many reorganisations were needed to boost the academic value of the education. In the 1950s and 1960s various new study programmes and course tracks were introduced, primarily based on scientific disciplines and often resembling programmes in other academic institutes. The desire to become a university was formally satisfied in 1986 when the name Agricultural College was changed into Agricultural University. Based on that development a logical response to budget cuts and shrinking student cohorts would be that the Agricultural University would try to become a stronger competitor with other universities, either through its own force or through alliance building with other universities. However, the education system has changed in such way that the distinction between scientific agricultural education and vocational agricultural education was blurred rather than strengthened. Similar to the integration of research units, it is not unthinkable that the higher levels of agricultural education will be reunited in one organisation as well. Recent developments suggest that this option is preferred over the option to engage in the battle over new students independently or in strategic alliances with (faculties of) other universities. This preference is already visible in the contraction of the curriculum in the 1990s, induced by the rapid decline in student numbers. The question which programmes to keep and which to reduce or cut, laid bare the tension between the vocational or professional on the one hand and the scientific or academic on the other. The programme that attracted most students over the 1990s was the programme in biology, added as recently as the early 1970s, when academic attraction was still a major factor. But over the 1990s other universities, too, registered many students in general and applied programmes such as environmental studies and communication and management studies. The programme in biology at the Wageningen institution was maintained but other programmes were adjusted so that more attention was given to themes and issues in agriculture and society. In other words, the education is targeted at various social issues and themes from an integrated perspective, rather than specialised issues based on scientific disciplines. This focus will be conducive for a possible integration with the agricultural colleges, because of a similar issue-driven organisation of the education. However, other universities have a similar tendency to set up applied or issue-driven study programmes and therefore this focus cannot simply be characterised as a turn from the academic to the professional.

The recent integration of the various research units and education programmes at the Wageningen institution not only attracts the attention when compared with the developments between the 1960s and early 1980s. There is also a striking resemblance between developments in the Netherlands during the last four decades of the twentieth century and developments in the Dutch East Indies in the early twentieth century. In the 1900s and 1910s the debate concerning the organisation and status of public and private agricultural research in the Dutch colonies was fraught with the idea that research stations should be loci for pure and fundamental research. These bastions of science should not be polluted by the hands-on and feet-in-the-mud approach employed by graduates from the school in Wageningen. Through the 1920s and 1930s that view turned almost to the opposite. The colonial research and experiment stations were considered a shining example of how science was most affective when the fundamental and the applied worked closely together. Fifty years later this insight reappears in the organisation of agricultural science in the context of the Netherlands.

The organisation of agricultural science can be interpreted as an (institutional) adaptation to its context. In the colonial context academic attraction was not an issue for the research and experiment stations. Moreover, the agricultural scientists in the Dutch East Indies, especially those involved in indigenous agricultural production, had to work in social and ecological conditions that were very complicated compared to the situation in the Netherlands at that time. Natural conditions in the tropics complicated scientific research and technological improvements. Social and cultural differences in the archipelago complicated extension work and acceptance of technology. Many agricultural scientists translated (the awareness of) these difficult circumstances into more attention for the relation between science and practice. Integration of research, technologies and agricultural practice were considered crucial and self-evident features of agricultural science. The organisational setting of colonial agricultural research was far more conducive to such a perception, compared to the situation in the Netherlands. But in the last decades of the twentieth century, the conditions in which agricultural science in the Netherlands has to operate can in a certain way be characterised as "tropical conditions". In the second half of the twentieth century the natural and social environment for Dutch agriculture and (consequently) agricultural science has become more and more complex. This is partly a result of the vast growth in knowledge about all the interactions between agricultural production and the natural environment, partly because science itself has complicated (some will argue, messed-up) conditions for farming by introducing new technologies and science-based inputs. Moreover, social and cultural conditions have become very complex as well. Farmers have to deal with consumers who are very critical and often suspicious about the kind of food supplied and the way in which it is produced. Farmers and consumers together are critical and suspicious about the products and solutions developed by agricultural science. In other words, there is some similarity between the Netherlands of the late twentieth century and the Dutch East Indies early twentieth century. There are, of course, major differences between these time periods and contexts, but institutional thinking (vide Douglas) might be quite indifferent to such details and merely respond to overall features of its environment. Thus it is tempting to pursue the analogy for several reasons.

First of all, the analogy confirms a major theoretical notion underlying this thesis that institutional behaviour is not entirely erratic and unpredictable, but based on patterns and structural features. In this case it is the collective of agricultural scientists working in the colonies that responds to its environment in a way that is very similar to situation and development of agricultural science in the Netherlands over the 1990s. It is always nice to see a confirmation of an assumed structural coherence, but for the current developments in Dutch agricultural science a more challenging conclusion can be drawn. It might well be very fruitful for agricultural scientists dealing with a very complex natural and social working environment to study the institutional legacies current activities rely on, particularly those related to the science developed for tropical agriculture. In other words, the maxim that in order to know the future one has to understand ones own history might become more real for the Wageningen institution when its history in relation to tropical agriculture is taken into account. Therefore it is tragic to see that recent university reforms tended to devalue that history by downplaying the significance of North-South linkages.

The analogy also relates back to the earlier remarks about the future of agricultural research and education. Regarding the situation in the colonies the relatively flat organisational structure of agricultural science not only implied an organisational integration between fundamental and applied research but also an integration of these levels in concrete research activities and approaches. Similarly, it can be expected that a result from the recent changes in the organisation of Dutch agricultural science will be more emphasis on knowledge production and research approaches that link up various levels and components. In other words, there will be integration of knowledge in a vertical direction, meaning linkages between fundamental, applied and practice-research, as well as integration in a horizontal dimension, between various disciplines. The document quoted earlier about the strategic vision of the new Wageningen institution indeed stresses the need to integrate knowledge production in both directions. The question, however, is whether integration can move from the rhetoric of institutional profiling to actual research activities in various organisational units. Such a move will have all sorts of challenging elements and complications. If indeed, as suggested earlier, the agricultural science of the future is about matching views and models on different levels rather then imposing a single reductionist science model, then a major challenge is to develop the methods and tools for knowledge production in a way that such matching is possible. Debates and initiatives at Wageningen UR, following recent changes, suggest that such methods and tools are taken seriously, but they can also appear red herrings. One example is the renewed interest in interdisciplinarity, meaning cooperation between social and technical (or beta and gamma) disciplines. Stimulating interdisciplinarity is often assumed to result in better relations between science and the wider public. But also social scientists have difficulties to reason beyond their abstract models (theories) or transcend the policies formulated by the Ministry of Agriculture, and often have as little sense of (agricultural) practice and people's motivations as technologists. In other words, interdisciplinary cooperation (or beta-gamma interaction) will only be fruitful when targeted towards a better understanding of the relation between science and practice, including incorporating the reflexive findings of the kind of analysis attempted in this thesis.

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# Samenvatting

In dit proefschrift wordt aangetoond dat de Nederlandse landbouwwetenschap door de jaren heen steeds meer afstand heeft genomen van de (landbouw-) praktijk. Deze ontwikkeling is zichtbaar in de organisatie van zowel het onderzoek (hoofdstuk 3) als het onderwijs (hoofdstuk 4). De ontwikkeling is echter ook goed te herkennen in drie specifieke aandachtsvelden van de Nederlandse landbouwwetenschap, te weten de genetica en plantenveredeling (hoofdstuk 5), de rijstverdeling in voormalig Nederlands Indië en Suriname (hoofdstuk 6), en de ontwikkeling van statistiek en het gebruik van mathematische modellen (hoofdstuk 7).

De Nederlandse landbouwwetenschap is geïnstitutionaliseerd in verschillende organisatorische eenheden en locaties. Het belangrijkste instituut voor onderwijs en onderzoek is echter de Landbouwhogeschool (nu Wageningen Universiteit and Research Centre). In 1863 was de oprichting van een Rijkslandbouwschool geregeld in de nieuwe wet op het Middelbaar Onderwijs. Deze school, geopend in 1876, was aanvankelijk geen onderdeel van het stelsel van Hoger Onderwijs, maar in de eerste twee decennia van de twintigste eeuw werd de school omgevormd tot hogeschool. Ondanks dat de Wageningse instelling in 1918 academische status verkreeg, behield het (net als andere hogescholen) een aparte status in het academisch stelsel. Pas in 1986 werd dit formeel gelijk getrokken en werd de Landbouwhogeschool omgedoopt in Landbouwuniversiteit. Derhalve kan 1863 worden beschouwd als het beginpunt van de Nederlandse landbouwwetenschap en 1986 als het jaar waarin de landbouwwetenschap formeel de volwaardige wetenschappelijke status verwierf. Beide jaartallen vormen daarom het begin en eindpunt van de periode die in dit proefschrift is geanalyseerd. In deze periode onderging de verhouding tussen wetenschap en praktijk een aanzienlijke verandering.

In het eerste hoofdstuk wordt uiteengezet wat ik versta onder de relatie tussen theorie en praktijk in het licht van de ontwikkeling van de landbouwwetenschap. In dit hoofdstuk worden vier theoretische stromen uit de wetenschapsstudies besproken op basis waarvan de methodologische aandachtspunten voor deze studie zijn vastgesteld. Het eerste punt betreft de invloed van beroepsmatige concurrentie tussen landbouwwetenschappers en andere wetenschappers. Het tweede punt betreft de rol van de overheid in de bepaling van het doel en werkveld van landbouwwetenschap en in het vormgeven van de connectie tussen wetenschap en praktijk. Het derde aandachtspunt is het effect van sociale interactie en groepsvorming op de gezamenlijke denktrant ("*institutional thinking*") van landbouwwetenschappers. Tenslotte is er de sociale interactie tussen landbouwwetenschappers en niet-wetenschappers alsmede de 'interactie' met materialen, planten, dieren en andere organismen, waarlangs de grenzen van de landbouwwetenschap worden bepaald.

In hoofdstuk twee wordt de vraag gesteld op welke wijze wetenschap en landbouw zich tot elkaar verhielden voordat de Nederlandse overheid eind negentiende eeuw het besluit nam flink te investeren in onderwijs en onderzoek ten behoeve van de landbouw. In het hoofdstuk wordt duidelijk dat gedurende de gehele negentiende eeuw er uiteenlopende initiatieven waren om de relatie tussen wetenschap en landbouw te versterken, zowel in Nederland als in de koloniën. Pas op het eind van de negentiende eeuw werden overheid, wetenschappers en vertegenwoordigers van de landbouwsector het eens over de vorm waarin landbouwwetenschap zou moeten worden gegoten. In Nederland betrof de overeenstemming voornamelijk het onderwijs. In de koloniën draaide de discussie voornamelijk om de opzet van het landbouwkundig onderzoek.

In hoofstuk drie wordt verder ingegaan op de organisatie van het landbouwkundig onderzoek. In Nederland vond dit in de beginfase vooral plaats in landbouwproefstations, waarvan de eerste in 1877 in Wageningen werd geopend. Later volgden meerdere proefstations in verschillende plaatsen in het land. Begin twintigste eeuw ontstonden er ook andere organisatievormen van landbouwkundig onderzoek, zowel openbare als private instellingen. In de koloniën werden de eerste proefstations geopend door verenigingen van plantage-eigenaren. Onderzoek ten behoeve van de landbouw werd echter ook gedaan in de botanische tuin ('s Lands Plantentuin) in Buitenzorg (Bogor). Deze publieke instelling werd het hart van het koloniale Departement van Landbouw, opgericht in 1905. De organisatie van het landbouwkundig onderzoek ontwikkelde zich in de koloniën anders dan in Nederland. In Java (het belangrijkste eiland) ging de discussie vooral over het onderscheid tussen fundamenteel onderzoek (uitgevoerd door academici) en toegepast onderzoek (uitgevoerd door Wageningse afgestudeerden). Uiteindelijk werden beide typen onderzoek verenigd in één organisatievorm, proefstations. In Nederland ging de ontwikkeling precies de andere kant op. De integratie tussen wetenschap en praktijk werd eerst gekoesterd en verdedigd, maar langzamerhand werd de roep om onderscheid te maken in vormen van onderzoek steeds luider, resulterend in drie organisatorische niveaus, fundamenteel onderzoek (de laboratoria van de Lh), strategisch onderzoek (de instituten) en het praktijkonderzoek (de proefstations). Door deze hiërarchische opzet werd wetenschappelijke kennis en technologie vaak wel doorgesluisd naar de landbouwpraktijk, maar was er nauwelijks een terugkoppeling van kennis en inzichten vanuit de praktijk met de landbouwwetenschap. Een tweede consequentie van deze structuur is dat de Landbouwhogeschool zich bij haar ontwikkeling vooral oriënteerde op wat andere universiteiten deden, waardoor het aantal wetenschappelijke disciplines aan de Lh gestaag groeide. In veel gevallen was een directe aandacht voor de landbouw hierbij niet of nauwelijks te herkennen.

In het vierde hoofdstuk staat het wetenschappelijk onderwijs voor de landbouw centraal. Veranderingen in het curriculum, de programma's en specialisaties worden geanalyseerd in samenhang met de algehele organisatie van de Rijkslandbouwschool en Landbouwhogeschool. Vergelijkbaar met de ontwikkeling van het onderzoek stond in de discussie over het onderwijs de vraag centraal of er meer nadruk moest komen op disciplinaire specialisatie en het bijbrengen van onderzoekscapaciteiten of op een meer praktische benadering met een integratie van verschillende disciplines. Duidelijk wordt dat in de loop der jaren - en met name vanaf de jaren '60 - de eerste opvatting de boventoon voerde, met als resultaat een curriculum dat uitwaaierde over vele verschillende richtingen en mogelijkheden tot specialisatie. Parallel aan die ontwikkeling verschoof de feitelijke machtsbasis van de Landbouwhogeschool van de Senaat (vergadering van hoogleraren) naar de verschillende (disciplinaire) vakgroepen. Verder blijkt dat ondanks alle moeite die werd gestoken in programmering, studenten er vaak in slaagden een eigen vakkenpakket op te bouwen, los van de ideeën van professoren en bestuurders. De ontwikkeling naar een overwegend disciplinaire differentiatie van het onderwijs maakte dat er steeds minder aandacht was voor kennis over en vanuit de (landbouw)praktijk. Ook in het onderwijs groeide derhalve de afstand tussen wetenschap en praktijk.

In hoofdstuk vijf wordt verder ingezoomd op de organisatie van genetica en plantenveredeling in de landbouwwetenschap. Aangezien deze vakgebieden zich richtten op een groot aantal gewassen is tarwe gekozen als 'voorbeeldgewas'. Naast technische en wetenschappelijke kwesties hielden genetici en veredelaars hielden zich vooral bezig met de vraag hoe hun vakgebieden het best georganiseerd konden worden en hoe de relatie met de zaaizaadsector en landbouw er uit zou moeten zien. De gekozen oplossing bepaalde in grote mate de organisatie van de Nederlandse zaaizaadsector. Een belangrijke bevinding van dit hoofdstuk is dat het Instituut voor Plantenveredeling (verbonden aan de Lh) haar centrale positie in de zaadsector niet had te danken aan de autoriteit van wetenschappelijke kennis, maar aan de autoriteit van het Ministerie van Landbouw. Toen die centrale positie eenmaal was verkregen, distantieerde het instituut zich van de meer praktische zaken, hoewel het onderzoek sterk gericht bleef op de veredelingssector. Met andere woorden, de formele band tussen wetenschap en praktijk werd grotendeels verbroken en hing voornamelijk af van de aandacht en inzet van individuele onderzoekers.

In hoofdstuk zes wordt gekeken naar de ontwikkeling van de rijstveredeling in de koloniale context. In tegenstelling tot de situatie in Nederland werd de plantenveredeling niet opgezet in samenspraak met kwekers, zaaizaadbedrijven en landbouworganisaties. De zaaizaadsector in voormalig Nederlands Indië was minder duidelijk georganiseerd en bovendien verstonden de Nederlandse wetenschappers, (voornamelijk) Chinese zaadhandelaren en Javaanse boeren elkaar slecht, in de letterlijke en figuurlijk zin van het woord. In tegenstelling tot in Nederland lukte het in de koloniën niet om in enkele decennia een gereguleerde zaaizaadsector op te zetten. Derhalve werd in de discussies over de organisatie van de rijstveredeling veel aandacht besteed aan de vermeerdering en introductie van nieuwe rijstvariëteiten. Kortom, er was relatief veel aandacht voor de relatie tussen wetenschap en praktijk. Tegelijkertijd ondernamen koloniale ambtenaren, landbouwkundigen en waterbouwkundigen pogingen de praktische en sociaal-culturele beperkingen van de traditionele rijstverbouw te omzeilen door polders te ontwerpen waar gemechaniseerde rijstverbouw kon plaatsvinden. In voormalig Nederlands Indië kwam dit nooit verder dan het experimentele stadium. In Suriname werd eind jaren veertig een semi-overheidsbedrijf gesticht dat grootschalig gemechaniseerde rijstteelt introduceerde. Dit bedrijf kon echter alleen overleven met overheidssteun. Na verloop van tijd realiseerde men zich dan ook dat dit project zich meer moest gaan richten op de lokale boerenbedrijven om een positief economisch effect te hebben. Kortom, de wetenschap bleek niet in staat om de praktijk geheel naar haar hand te zetten.

Het onderwerp van hoofdstuk zeven is de landbouwstatistiek, opgevat als numerieke abstractie zoals dat op verschillende manieren werd en wordt gebruikt in de landbouwwetenschap. Het eerste deel van het hoofdstuk beschouwt de ontwikkeling van de agrarische economie of, zoals het vroeger werd genoemd, de landhuishoudkunde. Landhuishoudkunde ontstond door de gezamenlijke inspanningen van overheid en wetenschap om de productiviteit van de landbouw te meten en te waarderen. In de koloniale situatie werd deze kwantificering gebruikt om belasting te heffen, de zogenaamde landrente. De koloniale Landbouwvoorlichtingsdienst gebruikte dezelfde gegevens om zich een beeld te vormen van de Javaanse boer als een serieuze (rationele) partij in het proces van technologieoverdracht en agrarische ontwikkeling. Het tweede deel gaat in op de introductie van wiskundige statistiek bij de opzet en organisatie van proefvelden. Statistische methoden en proefveldtechnieken beïnvloedden elkaar wederzijds. Een belangrijk aspect van deze ontwikkeling in de Nederlandse context is dat de voorlichtingsambtenaren niet erg enthousiast waren over de introductie van statistiek. Ze vreesden dat ze het vertrouwen van de boeren zouden verliezen als resultaten van veldproeven alleen zichtbaar zouden zijn in uitkomsten van statische berekeningen. Het laatste deel van het hoofdstuk gaat in op het gebruik van lineaire (in plaats van stochastische) modellen in de landbouwwetenschap. Duidelijk wordt dat de oorspronkelijke vraag - is het mogelijk lineaire modellen toe te passen op de levende natuur - geleidelijk aan werd vervangen door de vraag of de landbouwpraktijk aangepast diende te worden aan de modellen of andersom? Als gevolg daarvan kwam de 'gemodelleerde praktijk' tussen de landbouwpraktijk en de wetenschap in te staan.

Hoofdstuk acht bevat de conclusies van het proefschrift en een postscriptum waarin enkele recente ontwikkelingen in de landbouwwetenschap worden beschouwd. De belangrijkste conclusie van het proefschrift is dat in de ontwikkeling van de landbouwwetenschap de afstand tussen wetenschap en praktijk geleidelijk aan groter is geworden. De organisatie van het landbouwkundig onderzoek ontwikkelde zich in een gelaagde, hiërarchische structuur. Een belangrijk effect van die hiërarchische differentiatie was dat de landbouwwetenschap zich voornamelijk oriënteerde op de wetenschap en in veel mindere mate op de landbouw. De relatie met de (landbouw)praktijk werd gezien als een zorg voor de proefstations en de voorlichtingsdienst. Deze hiërarchische organisatie werd voor een belangrijk deel mogelijk gemaakt door de nauwe banden met het Ministerie van Landbouw. Dit ministerie was formeel verantwoordelijk voor de relatie tussen wetenschap en praktijk, waardoor de landbouwwetenschappers zich daar verder geen zorgen over hoefden te maken. Als gevolg hiervan was de dynamiek van de landbouwwetenschap steeds minder afgestemd op de dynamiek van de (landbouw)praktijk. Ontwikkelingen vanaf 1986, beschreven in het postscriptum, laten zien dat wetenschappers en ambtenaren deze groeiende afstand tussen wetenschap en praktijk probeerden te verkleinen. De belangrijkste verandering is een nieuwe organisatorische structuur waarin de wetenschap meer verantwoordelijk wordt voor het creëren en in stand houden van een band met de praktijk. De veranderingen in de organisatie roepen echter nieuwe vragen op waar de landbouwwetenschap de komende jaren aandacht aan zal moeten besteden.

# Curriculum Vitae

Harro Maat was born on 6 December 1967 in Beilen as the ninth child in a family of ten. He went to primary school in the same town and spent most of the weekends and holidays at his uncle's farm. Secundary school was in a somewhat larger town nearby and in his teens he learned that the world was bigger than the province of Drenthe and more complex than playing on a farmstead. In 1986 he went to the Agricultural University in Wageningen, following the study programme in irrigation and water management. During his study he gradually switched focus from the technicalities of irrigation to the social and historical elements of science, technology and agriculture. He graduated with distinction in 1993, starting two years later with his PhD research at the Technology and Agrarian Development group.

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