Developing institutional collaboration between Wageningen University and the Chinese Academy of Agricultural Sciences

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Abstract

Scientific co-operation between the Chinese Academy of Agricultural Sciences (CAAS) and Wageningen University (WU) has been underway since 1990, especially in the field of plant sciences. In 2001, CAAS and WU initiated a formal joint PhD training programme to further structure their co-operation. The goals of this co-operation are to: (1) initiate long-term institutional collaboration through capacity building; (2) jointly establish a modern laboratory; (3) jointly develop a cross-cultural scientific culture, and (4) set up collaboration in specific fields. Proper selection of PhD research themes was very important in the starting phase, since it would be a basis for good future collaboration. Both the culture and the educational system in the Netherlands and China are very different and this is reflected in their respective PhD educational systems. This article describes the joint PhD programme against the background of these different cultural settings and the different mandates for research of both WU and CAAS. It provides an overview of the requirements and discusses ways to develop a successful co-operation between WU and CAAS.

Additional keywords: vegetable genomics, cultural context, educational system.

Introduction

Scientific co-operation between the Chinese Academy of Agricultural Sciences (CAAS) and Wageningen University (WU) has been underway for more than 15 years, especially in the field of plant sciences. A total of 28 CAAS PhD students did their research at Wageningen (either as full-time student in Wageningen or as a sandwich PhD student initiating a research programme at Wageningen University, conducting research at

CAAS and writing the thesis at Wageningen University) and obtained a Wageningen University PhD degree. Several of these Chinese alumni returned to China where they made good careers and continued collaboration with their WU supervisors. In order to further structure and strengthen the scientific co-operation between Wageningen University and CAAS, a memorandum of understanding was signed by both parties, and a formal joint PhD programme was initiated. An important aim was to develop institutional capacity in China for research, training and extension in the areas of vegetable genomics and food production and to create a strong basis for future WU–CAAS institutional collaboration. Besides capacity building, the programme aimed at the development of a joint, modern research culture, also by the establishment of a joint Sino–Dutch vegetable genomics laboratory at CAAS. Proper selection of research topics by WU and CAAS scientists for PhD students was very important, since it would form a basis for future successes. The WU–CAAS PhD students conduct part of their research project in Wageningen University and part at one of the CAAS institutes. The most common format is to start the research in Wageningen, continue at CAAS and return to Wageningen to finalize experiments and write the thesis, the so-called sandwich PhD construction. The initial intention of the programme was to grant the students a joint WU–CAAS PhD degree, after fulfilment of all requirements of both the CAAS graduate school and the Dutch graduate schools involved (in this case, the graduate schools for Experimental Plant Sciences and for Food Technology, Agrobiotechnology, Nutrition and Health Sciences).

The evolution of the joint PhD programme was strongly influenced by the different academic settings and cultures in WU and CAAS. This paper describes this evolution as a case of academic co-operation between Dutch and Chinese institutions. Our aim is to identify specific problems and opportunities in this co-operation and possibilities for improvement.

Institutional settings

Wageningen University

General

Wageningen University stands for higher education and research in the fields of nutrition and health, durable agro-systems, 'green' environment and societal changes. Fundamental and applied research are utilized in an innovative systems approach, with an interdisciplinary, international, and interactive orientation. In 2003/2004, nearly 5000 students from all over the world were enrolled on 19 BSc and 28 MSc programmes. Twelve hundred PhD students were enrolled, and the number of PhD graduations per year was around 200. For 13 years, the PhD educational system in the Netherlands has been organized through graduate schools. Dutch graduate schools direct the university research and guard its quality. They are focused on themes and are not necessarily confined to a single university. Several Dutch universities participate in the graduate school of Experimental Plant Sciences (EPS) (Anon., 2005), which was established in 1992 and received accreditation as a graduate school by the Royal

Netherlands Academy of Arts and Sciences in 1993, 1998 and 2003. EPS' mission is to organize the training that should make PhD students and post-docs self-reliant, societally skilled researchers in the plant sciences and to create a national platform for academic experimental plant scientists. Within the course programme of EPS, seminars and specialized courses for PhD students from EPS itself and other (Dutch and foreign) graduate schools are of major interest. Internationally recognized scientists are invited for the seminar series, and students actively participate in the preparation and organization of the specialized courses.

PhD system

When WU scientists have obtained project funding for a PhD position, the position is advertised and the most suitable applicant is selected. The graduate school requires a research proposal in the first half year that needs to be approved by a number of external board members. Additionally, every PhD student has to define a training and supervision plan (TSP) together with his supervisor. This TSP describes planned activities, like courses to take, participation in seminar series and thematic schools, attendance of conferences and teaching duties, and has to be approved by the graduate school. With an approved TSP the student obtains funds to follow a teaching programme and an EPS certificate upon graduation. In short, the graduate-school monitors the progress and guards the quality of the PhD research. The PhD student is expected to graduate within four years. (The Ministry of Agriculture, Nature and Food Quality pays a considerable amount to the university for each PhD graduation, which represents a significant part of its basic funding as part of a system of output-financing.) The PhD student submits his thesis to a reading committee and – after approval – defends his thesis in a public ceremony in the auditorium of Wageningen University for a scientific committee of four opponents, 1–3 co-supervisors and the Vice-Chancellor or one of his deputies. After successful defence the PhD degree is conferred.

Chinese Academy of Agricultural Sciences

General

The Chinese Academy of Agricultural Sciences is a national agricultural research organization directly affiliated to the Ministry of Agriculture of China. It conducts research that is important for the development of the Chinese rural economy, with a focus on crop sciences, food quality and safety, natural resources and environment research, livestock research, biotechnology, agricultural information, agricultural economics, and food processing. At present, CAAS has 41 research institutes and a graduate school. Of these research institutes, 16 are engaged in plant research, 10 in animal husbandry, 8 in economy and environment, and 5 in agricultural engineering and technology.

Each year the CAAS graduate school enrolls 120 PhD and 150 MSc students (2004 data). The graduate school is responsible for the graduate educational programme and organizes both theoretical and practical courses for the graduate students. The courses are given by teachers employed by the graduate school. In addition, experts from CAAS institutes and universities are often invited to give lectures. PhD students take

six months of course work before they start their PhD research. The CAAS graduate school is responsible for student administration and provides dormitories, monthly allowances etc.

PhD system

Chinese students or employees with a MSc degree can participate in PhD entrance exams of CAAS or other academic institutions. Proficiency in English and a number of topics relevant for the PhD student (e.g. molecular genetics) are examined. Prior to the exams, the candidate has already contacted potential supervisors appointed by the CAAS graduate school, about possible thesis research. After passing the exam, the candidates are interviewed by the supervisors, and those with the highest ranks are usually selected. The graduate school assigns the students that could not follow their first choice to other supervisors. The PhD research project is often defined after the PhD student joins the supervisor. Supervisor and student select graduate courses to be taken in the first 6 months, which need to be approved by the CAAS graduate school. After this course work, the student is completely involved in the research programme of the individual groups and there are no joint activities with PhDs at other institutes. A CAAS PhD student should graduate in 3 to 4 years. Both the CAAS graduate school and the Science and Technology Departments of the institute where the student conducts his research play a role in the quality control of PhD projects. They organize mid-term evaluations and give approval to the students to prepare and defend their theses. Theses are defended in the CAAS institutes where the students have done their research. The PhD diplomas are presented two times a year during official CAAS MSc/PhD graduation ceremonies.

The joint WU–CAAS sandwich PhD programme

In February 2001, the joint WU–CAAS sandwich PhD programme for vegetable genomics was launched. Its aim was the production of healthy food for a growing population, produced in an environmentally sustainable and economically viable way. The programme was financed on a fifty–fifty basis by WU and CAAS and envisaged the establishment of a joint Genomics Laboratory at the CAAS Institute of Vegetables and Flowers (IVF-CAAS) as well as 15 sandwich PhD projects. In May 2001, a memorandum of understanding describing the planned activities was signed by the Vice-Chancellor of WU and the president of CAAS. The sandwich PhD would start with graduate coursework at CAAS, followed by research in the Netherlands, in China, and finally again in the Netherlands. It also stated that the final product would be a WU and a CAAS PhD degree, but it did not mention a joint degree. The budget per student would cover a one-year stay at WU. It was anticipated that the PhD candidate would obtain a WU degree four years after enrolment on the CAAS courses.

It was further agreed that both WU and CAAS would appoint a programme co-ordinator to manage the programme, ask WU and CAAS scientists to propose research topics and monitor students. The Dutch graduate schools needed to approve all PhD research proposals on the basis of their own quality criteria. The CAAS graduate

school would pre-select PhD candidates qualified to enter the programme in agreement with CAAS supervisors.

At the start of the programme there was a clear expectation to initiate joint research in the follow-up phase in selected areas based on joint scientific input. Another common understanding was that the fields of collaboration would be broadened in the future, and that educational programmes and a protocol for a joint WU–CAAS graduation would be developed.

The arrangements that were agreed on at the start of the programme can be listed as follows:

1. Both the CAAS graduate school and the Dutch graduate schools EPS and Food Technology, Agrobiotechnology, Nutrition and Health Sciences (Dutch acronym VLAG) were involved. The CAAS graduate school was charged with selection of PhD candidates (with their supervisors) and advertisement of the programme in China. The Dutch graduate schools EPS and VLAG had to approve the PhD project proposals and would monitor the progress of the projects.
2. Both CAAS and WU appointed a programme co-ordinator who would be responsible for the programme management. The co-ordinators would promote the programme at WU and CAAS, contact WU and CAAS scientists who could play a role in the programme and collected PhD research proposals. At later stages the programme co-ordinators monitor the progress of the individual PhD projects and organize regular work discussions for the PhD students. They also look for financial possibilities for a next phase of the programme.
3. The programme board (with staff from the CAAS graduate school, the CAAS International Co-operation Department, the CAAS Institute of Vegetables and Flowers (IVF-CAAS), the WU programme leader and co-ordinator and a representative of the graduate school EPS) was in charge of the overall evaluation of the programme and would indicate perspectives for future co-operation.
4. PhD students and their (co-)supervisors actually conducted the research that should result in theses that would meet both WU and CAAS quality standards.
5. A Sino–Dutch vegetable genomics laboratory was established at IVF-CAAS. It enabled students to conduct their research, but also assured a central location where students could work and discuss their research jointly. PhD students affiliated to other CAAS institutes conducted their research either at the joint laboratory or in the laboratories concerned. In Wageningen, the PhDs conducted their research in the different laboratories that were involved.
6. The programme would be funded for 50% by WU and for 50% by CAAS. The total budget for five years was two times 1.64 million euros.

Evolution of the programme

Financial aspects

Although it had been agreed that the programme was to be funded by CAAS and by WU on a fifty–fifty basis, at the beginning of 2001, WU only had guaranteed funding

for 25% from the WU Interdisciplinary Research and Education Fund (INREF). However, the WU programme co-ordinator successfully applied for a grant from the Asian Facility programme. This was a subsidy arrangement of the Dutch Ministry of Foreign Affairs for collaboration with China in the field of Human Resource Development, with partners from the Netherlands and China both in higher education and in private enterprise. Through this grant, WU could not only fulfil its financial obligations and start the programme, but also extend the programme with a germplasm exchange project and the organization of a course in marker-assisted selection. This course is intended for Chinese plant breeders in collaboration with a Dutch vegetable breeding company.

CAAS obtained funding from grants of the Ministry of Agriculture and the Ministry of Science and Technology of China. Throughout the programme, both CAAS and WU successfully applied for additional small research grants for individual PhD projects (Table 1). The WU Laboratory of Plant Breeding also provided funding for a full time WU PhD position for an IVF-CAAS employee to clone late blight R genes

Table 1. Research fellowships to extend the research period at Wageningen University (WU), together with an International Foundation of Science grant for consumables in China.

No. PhD project [1]	Organization offering the research fellowship	Duration (months)	Consumables grant
1	Phytophthora Molecular Genetics Network (National Science Foundation–USA)	2	
2	Dutch Ministry of Agriculture, Nature and Food Quality	6	
	Huygens scholarship	10	
	EU project	6	
4	Dutch Ministry of Agriculture, Nature and Food Quality	9	International Foundation of Science, Sweden ($10,000)
	Laboratory of Plant Breeding (WU)	12	
5	WU sandwich project	12	
6	Dutch Ministry of Agriculture, Nature and Food Quality	2 × 6	
9	Dutch Ministry of Agriculture, Nature and Food Quality	6	
	Huygens scholarship	10	

[1] See Table 2.

from potato. In addition, Plant Research International (a Wageningen-based partner institute within Wageningen University and Research Centre) provided funding for a full time WU PhD position for an excellent CAAS student in bioinformatics.

Formulation of PhD projects

The vegetable genomics PhD programme formally started in spring 2001. The funds were for periods of 2 to 5 years, which resulted in a lot of pressure to start several PhD projects of common interest within the first year. The proposed projects all had to fit the 'vegetable genomics for improved human health' programme criteria, which implied that they had to deal with vegetable production in China and the Netherlands, and with related 'health aspects'. The latter covered breeding for resistance to diseases and pests (reduction of chemical residues in cultivation) and enrichment of health-promoting compounds, both micronutrients and secondary metabolites. At the start the availability of PhD project proposals was very unbalanced. There were many more WU proposals than CAAS proposals, mainly because the programme was better known in the former institution. The WU programme co-ordinator made visits to all possibly interested scientists in the Plant Science Group and the Agrotechnology and Food Science Group in Wageningen. Also, the EPS graduate school announced the programme to its members and wrote out a call for pre-proposals. In CAAS the situation was different. The CAAS programme co-ordinator was an employee of IVF, but the CAAS institutes that covered the disciplines of intended collaboration worked independently of each other. (The nutrition and agrotechnological research even resided in another Chinese Academy: the National Institute for Nutrition and Food Safety, Chinese Centre for Disease Control and Prevention.) Because of this situation, the CAAS co-ordinator needed formal introductions to these various institutes. The CAAS graduate school did not play a major role at this stage, but focused on the educational programmes and recruitment of PhD students. As a result, initially mainly IVF staff was informed. At the time IVF's core activity was the applied breeding of vegetables and flowers. The institute started to invest more seriously in genomics research only recently and particularly through the initiation of this joint PhD programme in Vegetable Genomics. IVF staff did submit a limited number of proposals, and in a later stage contacts were established with the Institute of Biotechnology, the Institute of Genetic Resources and the Oil Crop Research Institute. Even though few projects were initiated in CAAS, most WU projects were welcomed by scientists from different CAAS institutes, since they were in line with their research objectives. The research proposals originating in CAAS were worked out jointly to full proposals by WU and CAAS scientists.

Finally, 13 PhD projects were initiated. They can be grouped into four themes (Table 2). Theme *a* deals with several aspects of plant–pathogen/pest interaction. Theme *b* aims at the genetic modification of specific metabolite biosyntheses in tomato fruits for improved human health. Theme *c* focuses on micronutrient bio-fortification. It includes three projects: a genetic and a GMO approach to increase the bio-available micronutrient contents of *Brassica rapa*, which run parallel, and a project that analyses dietary patterns and the relative role of cereals and vegetables in meeting the

Table 2. The 13 PhD projects of the sub-programme Vegetable Genomics, grouped according to research theme, and the WU and CAAS institutes or laboratories involved.

	Theme and PhD project	WU [1]	CAAS [2]
	a. Resistance to diseases and pests		
1	Potato-*Phytophthora infestans* interaction; identification of race-specific avirulence genes in *Pytophthora infestans*	Phy	IVF
2	Potato-*Phytophthora infestans* interaction; evolution of resistance gene analogues in wild *Solanum* species	PRI	IVF
3	Tomato-*Cladosporium fulvum* interaction; identification and exploitation of key genes governing resistance of plants against pathogens	Phy	IVF
4	Tomato-*Oidium neolycopersici* interaction; differences of transcript profiles in basal defence, monogenic and polygenic resistance responses	PB	IVF, IGR
5	Characterization of virus diseases in peanut cultivation in China and generation of broad virus resistance	Viro	OCRI
6	Integration of host plant resistance and biological control in transgenic plants	Ent	IVF
	b. Plants enriched in health-promoting metabolites		
7	Genetic modification of folate biosynthesis in tomato fruits	PR [3]	Biotech
8	Phytoestrogens: health-protecting secondary metabolites; isolation of isoflavenoid prenyltransferase genes from plants	PRI	Biotech
	c. Micronutrient bio-fortification		
9	Controlling phytic acid and micronutrients as determinants of food quality: a genetic and physiological approach in *Brassica rapa*	PB, Gen, Phys	IVF, OCRA
10	Characterization and modification of Zn uptake and distribution in *Brassica rapa* vegetable varieties	Gen	IVF
11	Dietary patterns and the relative role of cereals and vegetables in meeting the nutrient requirements of people in China	PB, DHN	NINFS [4]
	d. Development of genetic material and bio-informatic tools		
12	Tomato functional genomics using activation tagging	PB	IVF
13	Haplotype block structure of tomato and its application in association studies	PRI	BFI

[1] WU = Wageningen University; PB = Laboratory of Plant Breeding; Phy = Laboratory of Phytopathology; Viro = Laboratory of Virology; Ent = Laboratory of Entomology; Gen = Laboratory of Genetics; Physio = Laboratory of Plant Physiology; DHN = Department of Human Nutrition.

[2] CAAS = Chinese Academy of Agricultural Sciences; IVF = Institute of Vegetables and Flowers; OCRI = Oil Crop Research Institute; Biotech = Biotechnology Institute; IGR = Institute of Genetic Resources; BFI = Bast Fibre Institute.

[3] PRI = Plant Research International (like WU part of the larger organization Wageningen University and Research Centre – WUR).

[4] NINFS = National Institute for Nutrition and Food Safety [not a CAAS but a CCDCP (Chinese Centre for Disease Control and Prevention) institute].

nutritional requirements of people in China. The objective of this third project is to predict the effect of consumption of *Brassica* vegetables with increased bio-available iron and zinc contents in alleviating micronutrient deficiency. Finally, Theme *d* involves projects that aim at making genetic material available for the public domain and at the development of bioinformatics tools. Because in many projects huge data sets will be produced (genetic markers, populations, transcription and metabolite data), tools to manage and analyse the data are essential to make the vegetable genomics programme a success.

Selection of students

When the Dutch programme co-ordinator visited CAAS in February 2001, the CAAS graduate school had already selected several promising PhD students who had just finished their course work and could start with research projects. Also IVF selected a number of employees who wished to pursue a PhD degree. Two of the nine candidates started in 2001 as sandwich PhDs on projects that had been proposed by WU scientists. One PhD candidate came from IVF and joined Project 6, supported by her supervisor who headed the IVF cabbage breeding programme. The other PhD student came from the CAAS graduate school and switched to another CAAS supervisor to enter the programme as a sandwich PhD student to study the tomato-powdery mildew interaction (Project 4).

The WU–CAAS programme board concluded that it would be better to start with selecting research topics rather than with PhD candidates. The supervisors at CAAS could then select suitable candidates for these topics. A meeting between the two programme co-ordinators and the CAAS programme board was planned at CAAS in February 2002, with the aim to select joint research topics. In that month, candidates who are planning to take entrance exams to start their PhD programme in September usually contact future promoters. With the joint research topics, CAAS promoters could attract excellent PhD candidates for the WU–CAAS programme. However, no jointly defined PhD projects were available at the time. A few CAAS proposals and 11 WU proposals had been formulated, but the latter still needed approval (conditioned on evaluation by external reviewers) by the graduate school EPS. Nevertheless, since there was ample interest of CAAS scientists in several of the WU pre-proposals, the process could continue. Four students were proposed by CAAS supervisors to join four WU proposals. In one case a CAAS supervisor even encouraged a student to switch to a supervisor who was more familiar with the proposed research. These students could only start in October or November 2002, since they had to wait until the pre-proposals were approved by EPS and until visas had been issued. It caused an unfortunate delay of 8–9 months for these students.

The last group of PhD students was selected by the CAAS graduate school and interviewed by WU staff in September 2002. These students just entered the CAAS PhD programme and started their course work. Even though WU research proposals had already been sent to CAAS in July 2002, neither students nor CAAS supervisors had been informed of these proposals by the graduate school. Despite this, six candidates could be selected who were considered very good and who were eager to join the

programme. These six candidates were already affiliated to CAAS projects and supervisors. In three cases their planned research at CAAS overlapped with the proposed WU research project. In the other cases, the students either persuaded their CAAS supervisors to let them join the project or (in one case) switched to another supervisor in order to start the research. This may be seen as a clear indication of the eagerness to co-operate and the admirable flexibility of the Chinese students and staff.

One project (Project 11, on dietary patterns and the role of vegetables in the diet of the Chinese population) was proposed by the late professor West from the WU Department for Human Nutrition in collaboration with the National Institute for Nutrition and Food Safety (residing under the Chinese Centre for Disease Control and Prevention) where professor West had regularly organized courses. The director of the department that was responsible for the data analysis of the China National Nutrition Survey 2002 became the PhD candidate for this project (the nutrition survey data form the basis of his thesis).

Management of the individual PhD projects

Most PhD students started their research at WU in a six- to twelve-month period after they had passed their CAAS course work. In this period, the students became familiar with the research project, the WU research group, and the techniques that were used. In some cases they had already written the detailed research plan and started the actual research. The students participated in work discussions of the WU research groups and occasionally presented their progress. They also participated in graduate school activities like 'flying' seminars or thematic days. The English language skills of the students were generally sufficient. Both the students and their (co-)supervisors were generally very positive about the progress that was made. Meanwhile, however, there was only sporadically contact with CAAS supervisors.

The return to CAAS often caused a serious delay in the progress. This was occasionally caused by a delay in the transfer of biological materials (problems with import), but more often the students simply needed time to set up experiments in the CAAS laboratory. A much more serious problem that appeared was the lack of supervision of the sandwich PhDs. Most projects had been defined by Wageningen University scientists. CAAS supervisors did not see themselves as the primary responsible and assumed that the one-year stay at WU had prepared the student sufficiently for an independent continuation. Also, the fact that the projects were defined by WU scientists meant that the necessary equipment was not always available for the students.

Programme management

Both at WU and CAAS the programme co-ordinators monitored the progress of the programme. At WU the sandwich PhD students were distributed over several laboratories and research groups. The students joined these groups and participated in their work discussions and other activities. The co-ordinator collected progress reports about the PhD projects twice a year and organized joint work discussions every few months where all PhD students presented their experiences. In CAAS, nine of the 13 PhD

students started to work at the newly established Sino–Dutch Vegetable Genomics Laboratory. The CAAS co-ordinator not only had to monitor the progress of the students, he also needed to furnish and manage the laboratory and supervise many of the sandwich PhD students together with the regular CAAS MSc and PhD students. He introduced weekly meetings where students every other week either presented their research or discussed selected papers from literature. Unfortunately, students who worked in other laboratories at the CAAS campus in Beijing did not join these meetings or other work discussions in their respective laboratories.

The Sino–Dutch laboratory

As envisaged in the WU–CAAS programme, a Sino–Dutch laboratory was established at IVF. IVF invested in laboratory space and equipment, and WU in additional equipment. The laboratory should not only facilitate the genomics research through the availability of equipment, but should also develop into a modern, high standard scientific environment for students and staff. When many sandwich PhDs and CAAS MSc and PhD students would conduct research at this location and participate in the work discussions this would increase both scientific and technical interaction. The Chinese programme co-ordinator, also director of the Sino–Dutch laboratory, visited Wageningen University several times, especially the Laboratory of Plant Breeding, in order to get ideas on how to organize the joint laboratory efficiently. In most WU laboratories, technicians rule the laboratory. They order chemicals and equipment, make stock solutions, participate in ongoing research, but they also design laboratory rules and protocols and make sure that all laboratory workers stick to them. However, the situation that has developed in the Sino–Dutch laboratory at IVF-CAAS is different. The technicians order chemicals and equipment, assist senior scientists, and often also have their own research, but they do not design rules and protocols nor implement those rules, probably because of differences in hierarchy. As a result, protocols are not standardized, different researchers use different solutions, and the cause of failing experiments cannot be deduced systematically. This situation makes the work in the joint laboratory less efficient, which is a general complaint of all sandwich PhDs. WU and CAAS programme co-ordinators together with the sandwich PhD students and other laboratory staff actively try to make the work in the joint laboratory more efficient and to give more responsibilities to technicians. These efforts are quite successful: there are good improvements in terms of centrally ordering chemicals, use of stock solutions, and implementation of common protocols and rules. Recently an IVF staff member obtained a WU PhD degree based on his research on characterization and cloning of late blight resistance genes in potato (Dr Sanwen Huang). He returned to IVF-CAAS to establish a Solanaceae laboratory, as an extension of the Sino–Dutch laboratory. Together with the CAAS programme co-ordinator his aim is to upgrade the Vegetable Genomics Research Group into a centre of excellence for Solanaceae and Brassicaceae research by optimizing its organization and the scientific climate.

PhD graduation

The initial plan was to grant the sandwich PhD students a joint WU–CAAS PhD degree, after successfully defending their theses in China for a WU–CAAS committee. This would necessitate the establishment of common norms for the PhD research duration, the format and content of the theses, the composition of the committee and the graduation protocols. Even though these items were discussed and solutions appeared to be at hand, the WU board was very sceptical about this format, and the idea was abandoned and not further considered. As a result, WU decided that the sandwich PhD students should obtain a WU degree, for which they should conform to WU standards, and CAAS decided that the students should obtain the CAAS degree beside the WU degree. As a consequence of this decision, the students needed to fulfil the requirements of both institutions. This decision has caused numerous problems for both the PhD students and the programme committee. Normally the CAAS degree is granted 3–4 years after enrolment of the student. As already mentioned, the joint-programme research projects were predominantly defined by WU scientists on the basis of WU PhD standards and a 4-year period. Whereas obtaining a WU PhD degree takes at least 4 years for regular students, the sandwich PhD students effectively can spend less than 4 years on research for the WU degree, since they also have to spend 6 months on CAAS course work. CAAS sandwich PhDs have a problem with the 4 years that are minimally needed to obtain their WU degree, not at the least because they obtain their final degree significantly later than their classmates. This situation is perceived as a failure and not as an opportunity. If the programme would become better known and prestigious in the future, these sentiments might perhaps disappear. A more practical reason for students to graduate first with a CAAS degree is that PhD students who already have a job, once graduated get higher salaries, bigger apartments and other benefits, like obtaining research assistants. These various considerations encourage the sandwich PhD students to pursue the CAAS degree as soon as possible, supported by their CAAS supervisors. However, since their research projects are based on a 4-year framework, the students can only produce relatively meagre theses after 3 years. (In general, the research data accumulate in the last year.) Current graduation conditions in CAAS involve the defence of the thesis in Chinese before a Chinese committee. The WU staff who was heavily involved in the project supervision cannot participate. After the students have obtained the CAAS degree (which again delays the research progress for 3–6 months), the WU degree is still relevant for students who want to pursue an international research career, but for those who aspire to a career in China, the international training that they have already received is sufficient and they will not continue their research for a WU PhD degree. Despite all difficulties, nine PhD students still decided to pursue a WU degree in addition to the CAAS degree, which indicates a strong commitment. This construction triggered a debate at Wageningen University whether a Wageningen PhD degree could be awarded on the basis of a one-year extension of a research programme for which a Chinese PhD was already awarded, even when the thesis would be a re-elaboration of the full four-year programme.

The problems that followed from a double graduation were discussed on several

occasions without a solution being found. In May 2005, the problem was raised once more in a meeting of WU and CAAS representatives. WU proposed that the WU thesis, written in English, with extensive Chinese and Dutch summaries, be also accepted for the CAAS defence. The dean of the CAAS graduate school answered that this would most likely be accepted, but proposed that this thesis would serve for a defence in Wageningen before a WU–CAAS committee, after which both the WU and the CAAS degrees would be awarded. This proposal has been sent to the boards of both CAAS and WU for approval. It is expected that CAAS will first approve this format. A first double degree was awarded on 3 October 2005 for PhD Project 4. The reverse format, a joint defence in China, needs to be discussed in WU and CAAS. However, the matter is still under debate.

Spin-offs

Capacity building

One of the aims of the programme is to enhance the capacity of CAAS staff in the field of genomics. The establishment of the Sino–Dutch laboratory was an important instrument to achieve this aim. The programme has now run for 5 years, and the laboratory has hosted many PhD students, MSc students and visiting scientists. The laboratory facilities have helped to successfully acquire research funding. Besides, most of the 13 students working at the joint laboratory or in other institutes gained international scientific experience and will use this to pursue their careers in China. The first sandwich PhD student defended his WU thesis in Wageningen in October 2005. After this he returned to his home university, Shangqiu Teachers College, where he will become head of the biotechnology research department and establish a research group that will collaborate with Wageningen University. IVF-CAAS certainly upgraded its genomics research and increased its research capacity considerably in 2005. As was mentioned previously, an IVF-CAAS employee successfully defended his WU PhD thesis in January 2005 and will establish a Solanaceae research centre in collaboration with WU scientists. IVF-CAAS doubled its laboratory space for this purpose.

Research collaboration

Throughout the programme, staff responsible for PhD supervision at both WU and CAAS obtained better insight into the conditions that should be fulfilled for creating a successful collaboration between the Netherlands and China. In November 2003 a workshop was organized at CAAS, which was attended by 20 WU scientists and many CAAS scientists. Contacts were made and new joint research proposals will be developed that can benefit from the existing collaboration.

Interdisciplinary research was initiated between vegetable geneticists at CAAS and WU and between nutritionists at the Chinese Centre for Disease Control and Prevention and WU. After a slow start, this interdisciplinary activity is now resulting in good interaction and in ideas for continued collaboration. New activities have already materialized on the basis of the existing co-operation programme. For example:

1. A three-year WU–CAAS programme to unravel the genetics of nutritional compounds in *Brassica* vegetables was granted by the Royal Netherlands Academy

of Arts and Sciences (KNAW) and the Chinese Ministry of Science and Technology (MOST). Beside IVF-CAAS and the WU Laboratories of Plant Breeding and the Product Design and Quality Management Group, the Beijing Vegetable Research Centre is involved because of its expertise in phytochemicals in Chinese traditional vegetables and its links with nutritionists and medical scientists.

2. A memorandum of understanding was signed between WU and CAAS, in the presence of the Chinese ambassador to the Netherlands, that envisaged WU–CAAS collaboration on potato late blight research and joint contributions to the international potato sequencing initiative.

Private sector initiative

A Dutch vegetable breeding company joined the programme by exchanging germplasm as a source of desirable traits for breeding and by giving a course in marker-assisted selection. These activities strengthened their ongoing contacts in China and resulted in the recent opening of a local breeding station in the Chinese province of Shandung.

Publications

The 13 PhD projects will result in several publications in both Chinese and international journals, expected in 2005–2007. Examples of publications *in press* can be found in Table 3.

Discussion

PhD graduation

An important issue that has been described in detail above is the PhD graduation. The original idea to establish a truly joint PhD programme resulting in a WU–CAAS degree, issued by a WU–CAAS committee, was abandoned. PhD students were required to pursue both a CAAS and a WU degree, based on a joint research project that had to meet both Dutch and CAAS graduate schools quality criteria. This arrangement caused numerous problems. The solution that surfaced in the May 2005 meeting of WU and CAAS board members – a joint defence before a WU–CAAS committee, after which a WU degree and a CAAS degree are awarded – would be a great step forward for the WU–CAAS PhD programme. The quality criteria of the joint thesis are currently being discussed, but most likely need to meet both WU and CAAS standards. The difference between these standards needs not be a problem, because CAAS wishes to upgrade its PhD theses. The most desirable solution from the viewpoint of WU is that a WU degree will be awarded and that this degree will then be endorsed by CAAS. CAAS prefers a solution where its role in the training of the PhD is formally acknowledged. In the INREF programme 'Convergence of Sciences' (Hounkonnou *et al.*, 2005), a similar problem of graduation standards in a joint PhD programme of WU and other academic institutions appeared. In this case, the solution will probably be a WU PhD degree that is defended at and endorsed by the African partner universities.

Table 3. List of scientific output of the programme: publications by PhD students.

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Wu, J. H. Schat, R. Sun, M. Koornneef, X. Wang & M. Aarts, 2006. New characterization of natural variation for zinc response and accumulation in *Brassica rapa* L. *New Phytologist*. (accepted for publication)

Yan, L., Z. Xu, R. Goldbach, K. Chen & M. Prins, 2005. Nucleotide sequence analyses of genomic RNAs of peanut stunt virus Mi, the type strain representative of a novel PSV subgroup from China. *Archives of Virology* 150: 1203–1211.

Zhao, J., X. Wang, B. Deng, P. Lou, J. Wu, R. Sun, Z. Xu, J. Vromans, M. Koornneef & G. Bonnema, 2005. Genetic relationships for *Brassica rapa* inferred from AFLP fingerprints. *Theoretical and Applied Genetics* 110: 1301–1314.

WU and CAAS objectives

For a truly joint PhD programme, knowledge of the different cultural contexts and educational systems in China and in the Netherlands appears to be crucial. When the joint programme was launched, the underlying rationales for WU and CAAS were not explicitly discussed. Both CAAS and WU representatives assumed that they pursued identical interests and objectives through the programme. In reality, CAAS's objectives

were more pragmatic. Rather than producing a number of excellent PhD theses, CAAS's primary interest was good education of its students, upgrading of its staff, and establishing a high level, modern vegetable genomics research laboratory that would guarantee high quality research and create possibilities for future collaboration. From this perspective, the programme was successful in all respects. The PhD students certainly increased their scientific abilities (no matter whether they will or will not defend a WU thesis). Even more importantly, despite all operational difficulties, WU and CAAS structured their relationships in an effective manner. Both a joint Brassicaceae genomics and a joint Solanaceae genomics programme are direct spin-offs of the programme. The joint laboratory for IVF is expanding, and through the joint workshop at CAAS in November 2003, many WU and CAAS scientists met and a number of joint projects are in the pipeline.

WU scientists also had the objective to initiate future collaborative projects. However, their primary aim was often to produce theses of a high scientific quality. In this respect, most projects listed in Table 2 will probably be finished successfully, but only at the expense of a lot of time and effort to keep the students going. In several cases, additional stays of the sandwich PhDs at WU laboratories proved to be necessary. Despite the fact that WU supervisors evaluated this as a laborious and difficult process, they do appreciate the numerous contacts that they have made in CAAS and in China, and the new collaborative projects that are being initiated. They are eager to continue the institutional collaboration, and the appreciation and respect for the Chinese students is very high.

Synthetic culture profiles of the Netherlands and China

In their book *Working with cultural differences*, Hofstede *et al.* (2004) described 10 synthetic cultural profiles that embody the most important aspects of national cultures. Even though these synthetic profiles are simplifications of the real world, they illustrate real tendencies. The profiles are opposite positions on five dimensions: identity (individualism versus collectivism); hierarchy (high power distance versus low power distance); sex (masculine versus feminine); truth (uncertainty avoidance versus uncertainty tolerance), virtue (long-term orientation versus short-term orientation). Three of these dimensions are important in view of the programme discussed in this paper: virtue, identity and hierarchy. In Chinese culture, both a long-term and a collective orientation loom large (Hofstede, 2001). In line with it, for the Chinese partners in the WU–CAAS programme, a long-term and institutionally oriented objective may have been most important: the establishment of a structural partnership resulting in future collaboration. From this perspective, the individual PhD projects are just steps along the way to a final goal. Besides, the Chinese culture is hierarchical. Students are far removed from power and have little influence on the structure of the programme. In comparison to the Chinese culture, Dutch culture has a more short-term and individualistic orientation. This makes the individual PhD projects more important. A successful PhD thesis contributes significantly to the prestige of the WU supervisor and his laboratory. Failure to meet the WU standards is seen as a personal failure of the supervisor and co-examiners and a drama for the student involved. Future collabo-

rations between WU and CAAS are regarded as welcome spin-offs, but they are not the primary objective of the individual scientists involved.

WU supervisors observe that students behave differently at WU and CAAS but do not see this in the cultural context. The sandwich PhD students who conduct their research alternately in WU and CAAS laboratories not only work in different organizations with different languages, but also in different cultures. In WU, students work independently and express their thoughts. They compare the programme structure and laboratory organization in WU and CAAS and discuss the difficulties that they expect when they will continue their project in China while they still need to meet WU criteria. Upon return to CAAS, the students do indeed meet the foreseen problems. However, they do not solve these through discussions with their supervisors or other relevant staff in CAAS. The main reason is that the student is not truly authorized to discuss problems with staff who are several levels higher in hierarchy.

Sandwich PhD students working in two cultural settings

As was described above, most PhD projects were defined by Wageningen University scientists. As a consequence, they reflected this university's focus on fundamental research. Applied research is not done in WU but in private companies and experimental stations. The situation in CAAS and the Chinese agricultural universities is different. Activities like the breeding of new varieties are core objectives. Since the focus is not solely on fundamental research, PhD projects in CAAS focus more on practical knowledge and the application of such knowledge. As a direct result, the requirements for discussions and supervision in CAAS and WU are different. In WU, PhD projects are often based on new concepts and need continuous innovation and creativity. This approach requires more interaction between students and their supervisors and other colleagues. In CAAS, PhD projects are more straightforward and generally fit nicely in the ongoing research, so that CAAS PhDs do not normally need intensive supervision and can often solve their own problems. These differences and their consequences were not recognized at the start of the programme. The WU scientists who defined the projects simply assumed that at CAAS the supervision of students and the way they were involved in discussions were comparable to the situation in their own laboratories. CAAS scientists, in their turn, accepted the WU PhD proposals, assuming that after a 6 to 12 month-stay in a WU laboratory, the PhD candidate would return well equipped to independently pursue the project. These two views obviously caused frictions between the students and their WU and CAAS supervisors in many projects. The WU–CAAS programme board can definitely be of help to improve this situation by organizing discussions at the start of each PhD project with both WU and CAAS (co-)supervisors. All aspects of the research should be discussed, and external supervisors at both WU and CAAS should be involved to give the PhD candidates support and advice where needed.

Conclusions

Both WU and CAAS are convinced that exchange of PhD students is important and should continue in the future. Despite the initial troubles and cultural differences that have been described, the programme as a whole is very successful in that a modern vegetable genomics laboratory has been established, 13 students have been educated at WU and CAAS, several follow-up projects have started and the exchange of students is continuing. For the next phase, WU and CAAS are developing regulations for co-operation in awarding PhD degrees. In the future more effort will be asked from the respective WU and CAAS supervisors to jointly define projects and obtain funding. This will most likely avoid problems for the PhD candidates who want to conduct their research in both WU and CAAS laboratories. Specific seed-money funds should facilitate the exchange of staff and students for short periods to continually develop joint research proposals. The spin-offs of the programme, represented so far by the WU–CAAS programmes on Brassicaceae and Solanaceae genomics, are clearly supportive of this approach.

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