AGRICULTURAL EXTENSION IN CHINA
CASE TIANJIN

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The development of China towards a market led economy stimulates the introduction of modern technologies in agriculture. For that purpose the municipality government Tianjin established in 1998 the Tianjin Agricultural Demonstration Centre for New and Advanced Technologies. At this centre modern varieties (hybrid seed material) of fruit-vegetables of Dutch origin were introduced as well as modern equipment for fertigation and climate control in the framework of a Sino-Dutch project. The project started in autumn 2000 and the major objective was to strengthen the research and extension capacity on sustainable vegetable production and marketing in Tianjin. The project was concluded at the end of 2002.
This report focuses on the extension aspects of the project. Separate reports are published about marketing and farm monitoring. The report gives a brief description on the agricultural extension system in China in general and a more detailed view on the situation in Tianjin. On the basis of the experiences during the evolution of the greenhouse horticulture industry in the Netherlands in the last fifty years the limiting factors in extension in Tianjin are analysed. The report concludes with recommendations on strengthening the practical applied cultivation knowledge and extension capacity in Tianjin in general and at the demonstration centre in particular.

Contents

PREFACE

The development of China towards a market led economy has substantially stimulated vegetable production. Within a short period, the vegetable industry has shifted from a shortage to a surplus economy and has to meet an increasing demand for high quality food, due to consumer concerns with respect to health and environment. In Tianjin, the fourth largest city of China, the vegetable production is mainly based on small size, single-household units. In this context LEI took the initiative for a project to improve the vegetable supply chain in Tianjin. For that purpose a consortium of Dutch and Chinese research institutions and private companies was established. The project, carried out from November 2000 till November 2002, was supported by the Asia-facility, a subsidy programme of the Dutch government to strengthen the co-operation between the Netherlands and countries in Asia. The project resulted in direct improvements in the vegetable supply chain with respect to production and marketing by seminars, courses and on-the-job training. The project progress and results are described in a concise final report "Strengthening research and extension on sustainable vegetable production and marketing in Tianjin" and separate reports on (a) marketing, (b) consumer preferences, (c) the use of agro-chemicals (farm monitoring), and (d) extension in Tianjin.

This report provides a description of extension system in Tianjin and provides recommendations for adjusting the system to the requirements of a market oriented agricultural sector, including the transformation from a top-down towards a participative approach. The following Dutch experts contributed to the extension component in the project: Ben Kamphuis, Peter Ravensbergen, Nol Verhaegh and XiaoYong Zhang of LEI BV, Bert Huizinga of IAC and Gerard Hulisz and Wenhu Li of Rijk Zwaan BV.

We express our thanks to our Dutch and Chinese partners in the project, in particular the staff of the institutions and companies who were directly involved in the project as well as the growers at the different project locations. We would also like to thank the Tianjin government for its valuable financial and institutional support.

Prof. Dr. L.C. Zachariasse
General director LEI B.V.

1 PROJECT BACKGROUND, OBJECTIVES AND ACTIVITIES

1.1 Project Background and objectives

The transition of China towards a market led economy has substantially stimulated vegetable production. Within a short period, the vegetable industry has shifted from a shortage to a surplus economy and has to meet now an increasing demand for high quality food due to consumer concerns with respect to health and environment. In Tianjin, one of largest cities of China about 120 km southeast of Beijing, the vegetable production is mainly based on small size, single-household units. The major market outlets are the large urban centres of Tianjin and Beijing, but Tianjin is also the second largest harbour of China (next to Shanghai) which creates opportunities for exporting vegetables to the South-East Asian markets (including Japan). However, currently the vegetable sector is hampered by the use of low quality seeds and inadequate production and marketing approaches. The research and extension infrastructure, which should support the growers in these fields, is insufficiently market oriented and does not effectively reach the growers.

Figure 1.1 Location of Tianjin in China

In this context the Tianjin Academy of Agricultural Sciences (TAAS), which plays an important role in the development of the agricultural sector in Tianjin, looked at possibilities for support by Dutch institutions and companies given the advanced horticultural industry in the Netherlands. A Dutch subsidy programme for enhancing public-private partnership between the Netherlands and Asian countries ("Asia facility") gave the opportunity for starting a joint project in the vegetable sector. For that purpose a consortium of Dutch and Chinese research institutions and private companies was established. The major objectives of the project were:

- To strengthen the research and extension capacities of TAAS;
- To foster the development of sustainable vegetable production by small growers in Tianjin;
- To improve the effectiveness and efficiency of the vegetable marketing chain in the Tianjin area.

The results of the project are described in the final report "Strengthening research and extension on sustainable vegetable production and marketing in Tianjin". The report at hand deals with the first extension activities. In other project reports the results of a farm monitoring study (Plant Research International) and a consumer survey in Tianjin (LEI) are published. Another report provides a description of the current marketing system in Tianjin and recommendations for improvements.

1.2 Project organisation and activities

The major partners in the project were the Tianjin Agricultural Demonstration Centre for New and Advanced Technology (TADC), a subsidiary of the Tianjin Academy of Agricultural Sciences (TAAS), Wageningen University and Research Centre (Wageningen-UR) and the Dutch seed company Rijk Zwaan. Furthermore, a group of pilot farmers has been selected from communities in Tianjin for inclusion in the demonstration and training activities. During the two years of project implementation, from November 2000 till December 2002, activities have been carried out around three dimensions: crop management, marketing and extension. The Agricultural Economics Research Institute (LEI) had the lead in the project. Rijk Zwaan provided vegetable seeds of different greenhouse vegetable crops and varieties to the involved growers. Stolze BV installed a modern fertigation system in three greenhouses at the demonstration centre. Plant Research International (PRI) set up a farm monitoring system to collect and analyse data on inputs and outputs in vegetable production in Chinese greenhouses. The activities of LEI were focussed on market research and chain management and LEI staff contributed also to improvements of the demonstration and extension capacities of TADC together with the International Agricultural Centre (IAC). Staff of TAAS and the extension bureau of Xinkou town were trained in different aspects of the supply chain in the Netherlands and on-the-job in China.

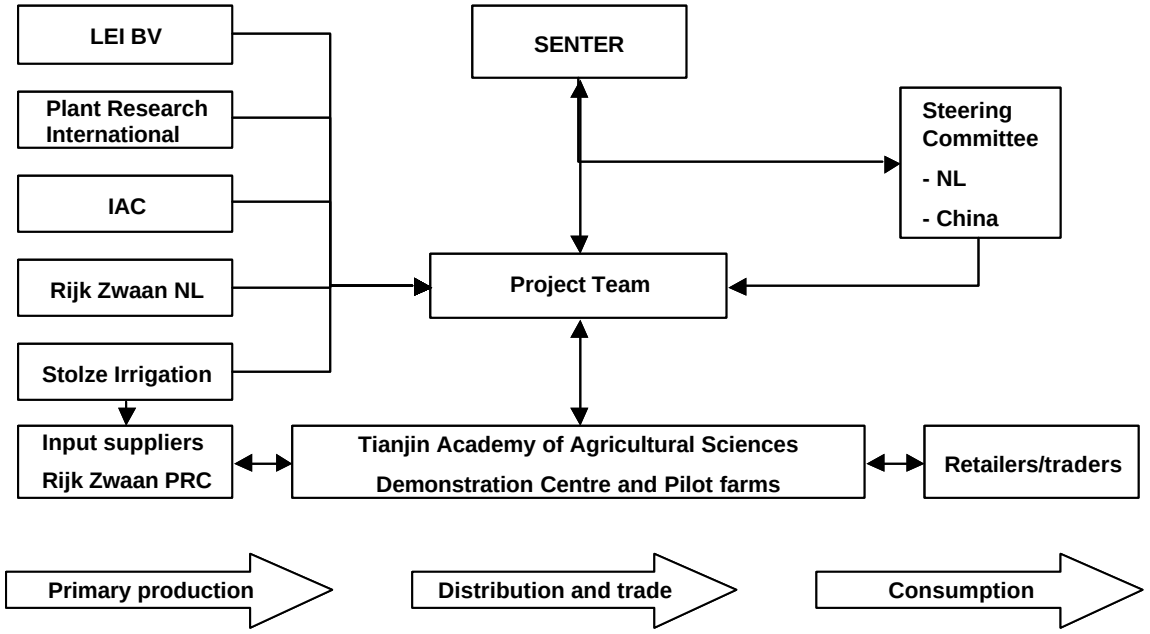

Figure 1.2 Project organisation

List of project activities

Phase 1 Inception phase (November - December 2000)
Task 1.1: Identification mission
Task 1.2: Exploring vegetable supply chain
Task 1.3: Identifying additional commercial partners
Task 1.4: Select satellite growers
Task 1.5: Project team building
Task 1.6: Start-up seminar
Task 1.7: Take go-no-go decision on development options

Phase 2 Institution building phase (January – March 2001)
Task 2.1: Training of trainers in the Netherlands *
Task 2.2: Development of extension curriculum *
Task 2.3: Extension meetings with growers *
Task 2.4: Preparation of demonstration fields *
Task 2.5: Supply chain & marketing workshops
Task 2.6: Preparation of monitoring systems
Task 2.7: Steering committee meeting
Task 2.8: Supply seed and other material

Phase 3 Pilot implementation phase (April - August 2001)
Task 3.1: Provide agronomic advice to growers *
Task 3.2: Organise demonstration days at TAAS and satellite farms *
Task 3.3: Collect and process farm and market data *
Task 3.4: Provide on-the-job training of TAAS staff *
Task 3.5: Intensify relations in the supply chain
Task 3.6: Organise project team workshops

Phase 4 Institutional strengthening phase: (September – June 2002)
Task 4.1: Analyse data of monitoring systems
Task 4.2: Organise refresher courses for trainers *
Task 4.3: Organise extension courses for growers *
Task 4.4: Organise workshop with project stakeholders
Task 4.5: Organise action plan for follow-up

Phase 5 Evaluation phase (July – September 2002)
Task 5.1: Provide seeds etceteras for second season
Task 5.2: Evaluation project results
Task 5.3: Organise start-up meetings for follow-up
Task 5.4: Organise national/international seminar in Tianjin
Task 5.5: Organise steering committee meeting

*The tasks marked with * are mainly focused on extension*

1.3 Contents of the report

This report describes and evaluates the extension system of Tianjin and provides recommendation to adjust the system to the requirements of a modern market oriented greenhouse sector. The following chapter provides a brief description of the technical results of the introduction of Dutch seeds in Tianjin. Chapter 3 gives a brief historical overview of the extension system in China and the current system in Tianjin. Based on the results of the project some major conclusions on extension in Tianjin are drawn. As an introduction to the requirements of a modern extension system, the evolution of the greenhouse horticulture in the Netherlands is described. On the basis of a comparison of the Tianjin horticulture with the Dutch sector recommendations are formulated for the development towards a professional extension service at TADC.
The information for this report is gathered by:
- Observations and conversations during field trips;
- Written and oral information from Chinese counterparts;
- Presentations and discussions during project seminars;
- Data collection by Chinese counterparts.

2 THE INTRODUCTION OF DUTCH VEGETABLES IN TIANJIN

2.1 The impact of the economic reform on the vegetable sector in Tianjin

The development of Tianjin vegetable production can be separated into two stages: before and after the economic reform. Although China's reform started in the late 1970s, the real liberalisation for vegetable sector began only in the late 1980s. During the central planning period, the Tianjin government had a detailed planning for the allocation of the vegetable production, the selection of crops and varieties and the distribution/marketing of the vegetables, produced by the collective farms. Following the economic reform policy of the central government Tianjin government gradually reduced its grip on the agricultural sector. In the 1990's the old market system with state-owned distribution centres and vegetable shops was shut down and hundreds of open (street) markets and wholesale markets came into development. In addition to the market reform the Tianjin government set up special funds for the vegetable sector to stimulate the use of new varieties and new technologies. A series of new varieties was introduced and the number of vegetable varieties sharply increased to about 200 in the year 2000 from the original 30 before the reform. The sown area of vegetables increased continuously during the last three decades and now ranks at the third place, after wheat and maize. In the 1970s and 1980s, most of the vegetables were grown in the open field. In 1987 the protected vegetable area, covered with plastic, was only 5,000 mu (1 mu = 0,067 ha; 1 ha = 15 mu). During the 1990s, the area of protected land expanded substantially. In 1996 the area was 42,000 mu and in1999 more than 300,000 mu, of which 62,000 mu green houses, 58,000 mu large plastic tunnels and 180,000 mu small tunnels. The production of vegetables showed an explosive growth since 1985 and reached 5,200,000 tons in 1999, as it is shown in figure 2.1. Within a short period, Tianjin vegetable industry shifted from a shortage to a surplus economy.

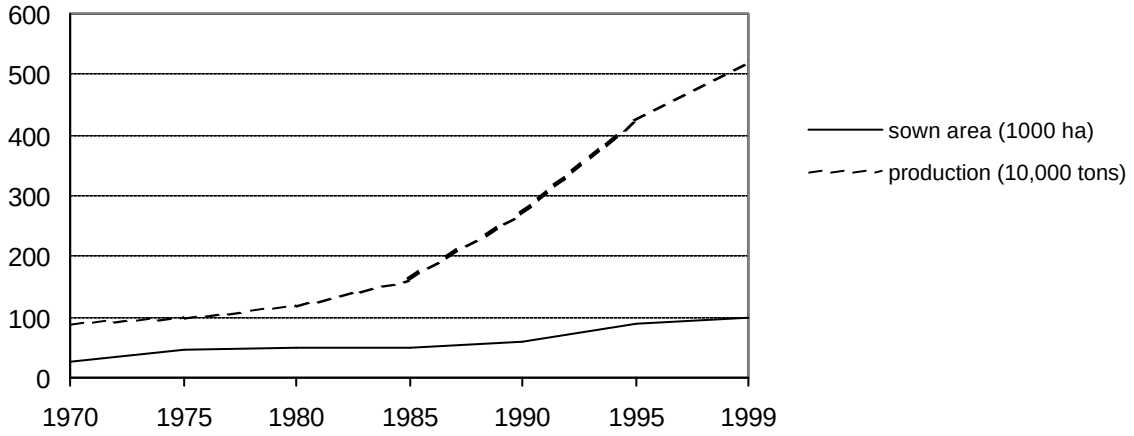

Figure 2.1. The Development of Tianjin Vegetable Production and Sown Area since 1970 (*Source: Fifty Years of Tianjin)*

As a result of the rising income and some severe incidents with food contamination, the Chinese consumers are becoming more concerned about the quality and safety of vegetables. In response to that Tianjin government started a new programme in 1999 called "Pollution Free Vegetables" (PFV). The PFV programme is enhancing the production of healthier food by the introduction of certain production standards. The PFV programme is an initiative of the Tianjin government and the standards for getting a PFV certificate are lower than those of the "Green Food" certificate that was issued by the Central Ministry of Agriculture. In order to obtain the certificate, various criteria have to be met with respect to:

- Production environment;
- Production technology;
- Product quality.

The production environment refers to the quality of soil, ground and irrigation water and air. The criteria for the production technology include regulations with respect to pest and disease control, the use of pesticides, the promotion of Integrated Pest Management (IPM), crop rotation and the use of

organic fertilisers. The product quality for non-pollution vegetables is regulated in standards with respect to the product appearance, packaging and labelling and a sanitary index, mainly referring to the contents of heavy metals (As, Hg, Cd, Pb, F, etc.) and chemical residues. The criteria are enacted by the Tianjin Agricultural Bureau. This bureau is also responsible for the implementation of the programme and for issuing the "Pollution Free Vegetables" production certificates. Up to now, 35 production sites have obtained this certificate, which allows them to sell their produce under the PFV label.

2.2 The project locations in Tianjin

The major counterpart in the project was Tianjin Agricultural Demonstration Centre for New and Advanced Technology (TADC). TADC was founded by TAAS in 1998 with financial support of the Tianjin government to foster the introduction of new technologies from other provinces in China and from foreign countries. The total area of the demonstration centre is 44 hectares. The demonstration centre has modern facilities for tissue culture, a nursery greenhouse, two large French double-deck green houses (total 10,000 m^2), 22 Chinese "sunlight" greenhouses (cultivated area 350 - 550 m^2 each), ten cool stores and facilities for sorting and packaging. In addition to that the centre has a demonstration hall and several meeting rooms. A large part of the area is in use for fruit, vegetables and flowers in the open, but the intention is to construct gradually more (different types of) greenhouses. The greenhouses in the project were built in 1998/99. In autumn 2002 twelve plastic

Figure 2.2 Tianjin Agricultural Demonstration Center for New and Advanced Technology

tunnels (of about 1 mu = 667 m^2) were built in order to increase the production capacity.
In addition to TADC, pilot farmers were selected in Xinkou Town. Xinkou town is located in the southwest of Tianjin and has a population of about 35,000 inhabitants (12,000 households) living in 18 villages. In the year 2000 about 20 % of the 50,000 mu arable land in this town is collective-owned and used for grain production. The rest is used for vegetable production by individual households with a scale of 3-10 mu per household. Farmers do not own the land but since the reform they rent the land from the local government for a period of 30 years. In 1999 about 75 % of the vegetable land is protected land cultivation, including 3,000 mu greenhouses, 5,000 mu large plastic tunnels and 22,000 mu small plastic tunnels.
Xinkou is one of the earliest “Pollution Free Vegetable” production bases in Tianjin with an area of 2,000 mu. Two locations in Xinkou town, Liu Fu and Dang Cheng were included in the project. In Liu Fu the village had financed the greenhouses built in 1999, while six farmers/shareholders were responsible for growing and marketing the crops. Seasonal labourers, however, provided most of the labour. The situation in Dang Chen was different. Forty growers established a Growers’ Association for Pollution Free Vegetable Production on the instigation of the Xinkou Agricultural Bureau. Seven out of these forty growers built 35 new greenhouses. These seven were selected by the Bureau and received loans from an agricultural bank to build the greenhouses. The Xinkou government guaranteed these loans but the seven concerned growers were personally responsible for the repayment.
In total a number of 80 greenhouses were included in the project, most of them Chinese "sunlight greenhouses", plastic covered greenhouses of about one mu (1 mu = 667 m2). These greenhouses have a brick or clay wall of about 3 meters high and 50 - 80 meters long on the northern side and a

Figure 2.3 The project locations in Xinkou town: Liu Fu and Dang Cheng

plastic dome on the southern side, which can be covered by roll down natural fibre screens (reed mats) (See the pictures in this report). They provide sufficient passive solar energy collection for fall and spring and require supplemental heating in winter.

The climate in Tianjin is hot in the summer and cold in the winter, semi-dry to humid. In January the average low temperature is about minus 8 degrees Celsius and the average maximum temperature in July is about 31 degrees Celsius. Annual rainfall is on average 525 mm, 80 % of which falls between July and September. Due to the cold winter and the hot summer mostly two crops are grown each year, one from late winter until summer and another from late summer till winter.

The spring season for vegetables in the non-heated greenhouses starts with sowing in January/February, transplanting takes place in March and the harvesting time last from March till July (until the heat is too much in summer). The seeds for the autumn season are sown in July/August and after transplanting in August/September the harvest last till December/January depending on the temperature.
If the greenhouse is heated, the harvesting time of the autumn crop can be extended until the new planting in March. Heating can be very profitable because of the high market prices before and during the Spring Festival (Chinese New Year) in February.

2.3 The results of the introduction of Dutch seeds

The project provided three times seed material, for the spring season 2001, the autumn/winter season 2001/2002 and the spring season 2002. The selection of crops and varieties was done in consultation among Rijk Zwaan, TADC and the growers at the other locations. The focus was on four crops: mini cucumber, medium-sized tomato, sweet pepper and eggplant of which different varieties were delivered. In December 2000, Rijk Zwaan delivered the first seed, just in time for the spring season. The seedlings were planted at TADC (11 sunlight greenhouses and 1 larger greenhouse) and two villages in XinKou town: Liu Fu village (43 sunlight greenhouses and 1 larger greenhouse) and Dang Chen village (35 sunlight greenhouses). Fifty-five of the greenhouses in these villages were built during the winter and came ready rather late for transplanting, one of the reasons for a low yield.
In August 2001 Rijk Zwaan delivered seed for the autumn/winter season, for in total 13 greenhouses at TADC, of which four with cucumber, tomato and sweet pepper each and one with eggplant. In December 2001 the seed for the spring season 2002 was delivered, sufficient for 44 greenhouses with cucumber, 44 with tomato, 9 with sweet pepper, 13 with eggplant and 3 with melon.

Most seedlings were grown in the nursery of TADC but part of it in the Chinese greenhouses at the other locations. The quality of the seedlings was in general good, but there is still much room for improvement. In all three seasons a substantial part of the seedlings were transplanted late because the greenhouses were not yet ready for transplanting (partly still under construction). As a result the production per hectare was not as high as it was anticipated. In the spring season 2001 the average yield of tomatoes was about 3.5 - 6.5 kg per m2, for mini-cucumber 2.5 – 5.0 kg and for eggplant and sweet pepper even less than 2 kg per m2. The sweet red peppers grown in the autumn season of

2001 were harvested before colouring red, because of the high heating costs and the decreasing prices. The yield was poor.
Although the Dutch varieties are known for their strong resistance against diseases, it appeared difficult for the growers in Tianjin to control diseases and pests. In the spring season of 2002 TADC succeeded in getting a much better yield for mini-cucumber, but the results were still far below the

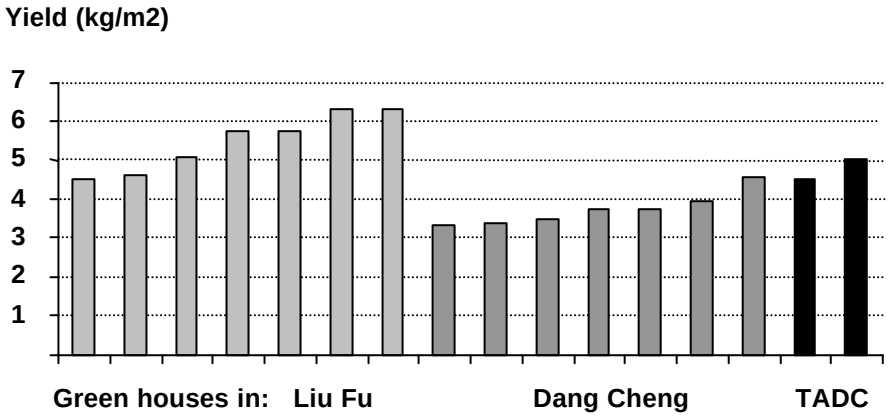

Figure 2.4 Yields per hectare tomatoes (Beril) at different locations in spring season 2001

yields in other production regions in China. The situation at the demonstration sites of Rijk Zwaan in Qingdao and Shouguang and of private growers in these regions showed that there are many possibilities for the Tianjin growers to improve the results. Yields of minimum 10 kg tomatoes or cucumber are very normal there. The poor results in Tianjin were partly caused by unfavourable physical (soil and water quality) and climatic conditions, but more important was the lack of knowledge, experience and skills of the staff and the workers in the greenhouses.

Figure 2.5 Differences is technical results, Tianjin - Qingdao

3 THE AGRICULTURAL EXTENSION SYSTEM IN TIANJIN

3.1 A brief historical overview of the extension system in China

The agricultural extension structure in China is built upon the central planning economy. There are basically four levels in terms of institutional administrative organisation, starting from top national level via provincial and county level down to township and village level. This top down approach is closely related to the actual circumstances at the time that the system was set up, such as the shortage supply of raw agricultural materials, a collective-owned land system and a less developed commodity economy. The development of the Chinese agricultural extension system can be described in four stages since the communist party came into power fifty years ago.

The first stage started at the early 1950s soon after the P. R. China was established. The Ministry of Agricultural designed a top-down national agricultural extension network. By the end of the fifties, more than half of the counties in China had agricultural extension stations. However, during *the second stage* (the 1960s), the newly developed agricultural extension system was destroyed by the Cultural Revolution and severe nature disaster. Agricultural extension officers were reallocated and assigned to other tasks. In the 1970s, *the third stage,* the agricultural extension recovered and was further expanded. Besides thousands of agricultural extension institutes at county level, extension stations were set up at around 26 thousands of communes and 300 thousands of production brigades (the lowest production unit at that time). At the top level, the Ministry of Agriculture was mainly responsible for the national agricultural extension activities. To a certain extent the National Committee of Science & Technology and the National Committee of Planning were also involved. *The fourth stage* refers to the last two decades of economic reform. During this period, the agricultural extension system went trough dramatic changes and this process is still going on. The first impact came from the introduction of the "Household Responsibility System", which claimed the individual farmers as the basic production unit, instead of the production brigades in the previous collective system. With the dismantlement of the extension structures at both commune and brigade level, the whole extension system came in a process of restructuring and readjusting. Several approaches have been experimented, such as converting the governmental extension organisations into independent companies, and encouraging other organisations (such as universities and research institutes) to extend their research results.

Intensive discussions are currently focusing on how the old extension structure could be reorganised in order to meet the new requirements and what methodological approaches are most suitable and useful in the current Chinese circumstances.

3.2 The agricultural extension system in Tianjin

The agricultural institutional structure in Tianjin is a complex network, both vertical and horizontal. The "Agricultural Committee" is the top decision-maker in Tianjin agricultural sector. Its main function is to enact development policy for Tianjin agriculture and to translate and implement national government's policy. The Agricultural Committee has seven functional departments. Since vegetable production plays an important role for a big city like Tianjin, it has been separated from other agricultural activities in an independent department within the committee. There are nine bureaux under supervision of Tianjin Agricultural Committee. See figure 3.1. These organisations cover all aspects of Tianjin agriculture from production, extension, education and research. The Agricultural Bureau is mainly responsible for crop production and technology extension. The State Farm Bureau is, on behalf of the government, managing and running state-owned farms. These state-owned farms are operating at a large scale and produce all sorts of products from cereals to livestock.

The Tianjin Academy of Agricultural Sciences (TAAS) is the major centre of expertise for agriculture in Tianjin with a staff of hundreds of researchers working in different research institutes, mainly in applied research. TAAS is in a process of re-orienting its research, training and extension activities into the requirements of the market economy. It supports the development of sustainable vegetable production that meets the consumers' demand.

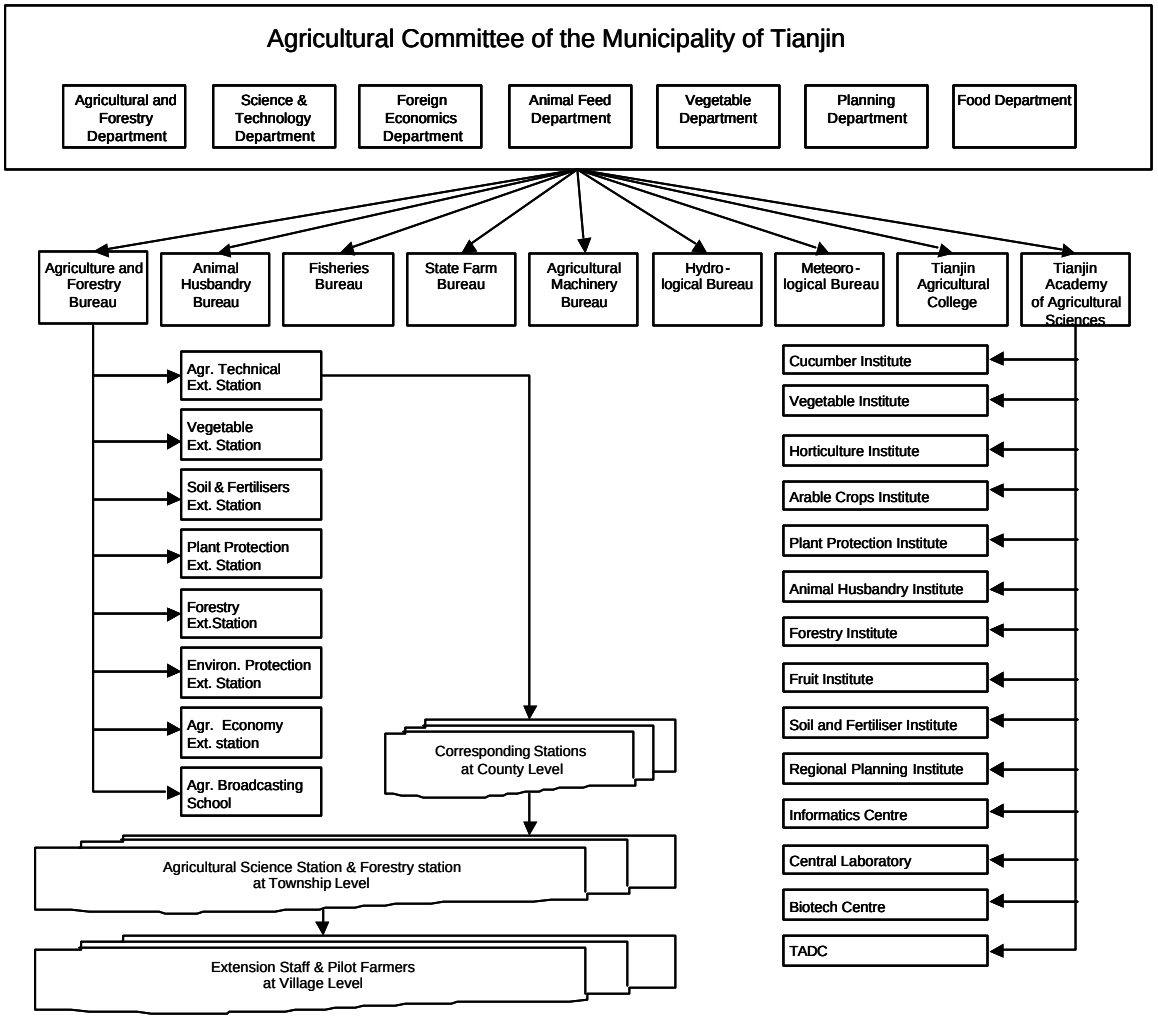

Figure 3.1 Tianjin Agricultural Institutional Structure

From an administrative point of view the current agricultural extension system in Tianjin can be categorised in four levels: municipality, county, township and village. The Tianjin Agricultural Bureau is the main responsible institute for managing and implementing extension activities *at municipality level*. There are within this bureau several extension stations with different functions, such as the agricultural technology extension station, the vegetable technology extension station, the plant protection station, the soil and fertiliser station, the environmental protection station, the seed station, etc. The agricultural technology extension station is only in charge of the extension works for grain crops, oil crops and cotton, not for vegetables; that is the task of the ve getable technology extension station. *At county level*, similar functional extension stations are set up in order to match up with the municipality level. *At township level*, there is only one station called 'Agricultural Science Experimental Station', which implements all extension activities. *At village level*, there are extension officers or pilot farmers available. Every village has at least one extension officer. Pilot farmers are randomly selected based on different activities or extension project.
The staffs at the three top levels belongs to governmental organisations with a total number of 1,700, while the extension workers at the 3,800 villages mostly are local farmers and they receive certain subsidies for their work. Figure 3.2 sketches the Tianjin agricultural extension system.

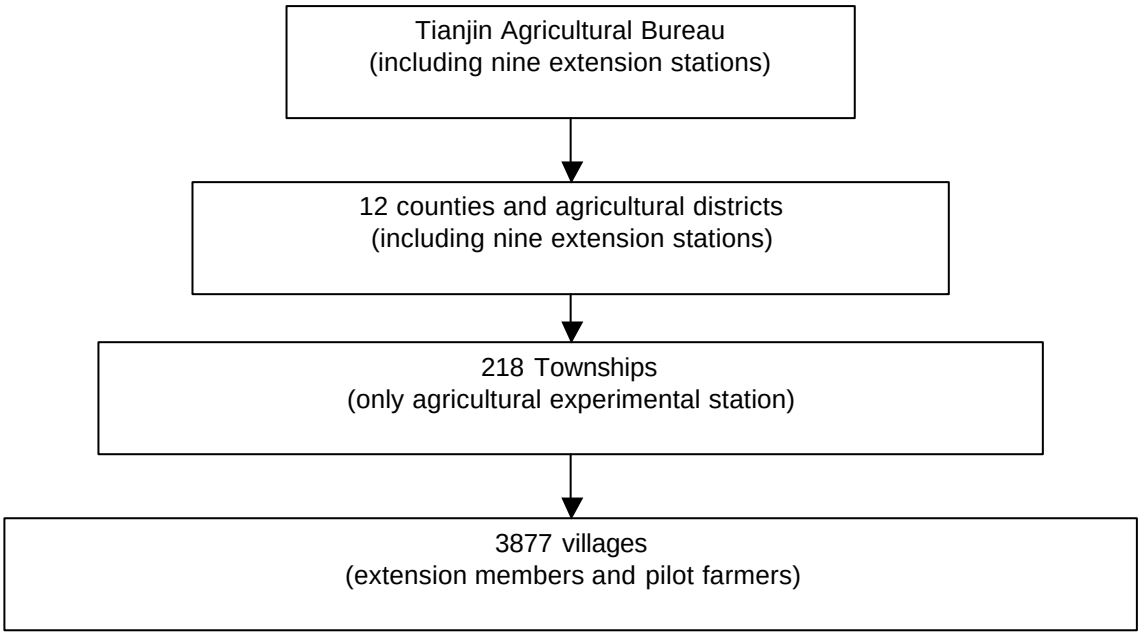

Figure 3.2 The Tianjin Agricultural Extension System

The Extension Structure in Xinkou Town

Xinkou town has an agricultural extension station. Its main task is to supply farmers with agricultural raw materials, such as seed, chemicals and machinery. In addition, this station also has experimental fields, where new varieties and new technologies are tested. Successful varieties are passed on to farmers via field training and lectures. More than 600 farmers from 18 villages are pilot demonstration farmers given their proficient vegetable cultivation technology.
Farmers' associations are developing lively in Xinkou. There are amongst others a "Chive Production Association", "Protected Land Production Association" and "Farmers' Technology Association". At the end of 1999, the first 'Pollution Free Vegetable Production Association' of Tianjin was established in Dang Cheng village. At the end of 2000, this association had more than 100 farmer members who ratified the associations' regulations regarding the members' duties and obligations that follow the 'Pollution Free Vegetable' criteria. The main goal of the association is to strengthen their marketing via the 'Pollution Free Vegetable' certificate and to improve the production technology.

3.3 Challenges of the Chinese Agricultural Extension System

The main methodologies used in agricultural extension include pilot experiments, field demonstrations, lecture training, farming interview and by means of newspaper, booklets and advertise. The traditional extension approach in China is based on the central planning system. As a result the current existing extension system has two major weaknesses:

The changing role of farmers in the knowledge system
During the central planning period, the central government designed the extension programme and selected certain new agricultural technologies for nationwide extension. From the top to the bottom, all extension institutes were promoting these new technologies until they reach the farmers. At that moment, farmers were collective farm members and had no decision power over what they wanted. Nowadays, however, farmers are independent decision-makers and their activities are profit driven. They only adopt new technologies if they can benefit from it. The top-down approach is no longer appropriate for agricultural extension. Instead, farmers' wishes and demands should be carefully considered. Strong involvement and participation of farmers are becoming more and more important to ensure the success of agricultural extension.

The limited scope of extension
The traditional agricultural extension was not only focused on 'transfer technology' to farmers, but this technology was also limited to 'strategic important' crops such as rice, wheat and maize. With the agricultural structure adjustment, more farmers have shifted to produce cash crops, for what purpose there is not technology available yet.
Furthermore, the contents of the agricultural extension should include a broad concept, such as farmers' communication among each other, informal agricultural education, etc. Chinese farmers strongly require new knowledge to improve their decision skill when they face a series of challenges in the market economy.

3.4 Extension activities in the project

One of the project goals was to strengthen the extension capacity in Tianjin, amongst others trough training of trainers. The training started with visits of staff of TADC and Xinkou Town to the demonstration centres of Rijk Zwaan in Qingdao and Shouguang in Shangdong Province in December 2000 and January and February (2001). Rijk Zwaan delivered lectures on practical cultivation techniques, required for growing the introduced Dutch vegetable varieties at TADC in Tianjin and visited the other project locations for direct advice to the growers. The following training activity concerned a three weeks training in the Netherlands in March 2001. Six experts from Tianjin followed an intensive course on extension methodologies at IAC in Wageningen and participated in a training at Rijk Zwaan Headquarters that covered all aspects of the vegetable supply chain, in particular the cultivation of vegetables in greenhouses. During the training in the Netherlands the focus was on the introduction of modern methods of extension and advise to farmers.

The day-to-day agronomic advice to the growers included in the project was provided by staff of TADC and especially by Xinkou Towns Extension Service. During several missions to Tianjin in April, May and June 2001, the Dutch extension experts spent most of their time on intensive consultations with the staff of TADC and Xinkou town and growers as well to determine an extension approach that suits the specific local circumstances.

Box 1. Contents of extension training at IAC in April 2001

A. Rural extension: challenges and prospects:
   - Extension and its major characteristics
   - Transfer of technology
   - Participatory extension approaches and social learning
   - The project structure

B. Building a participatory extension programme:
   - Communication and extension
   - Phases and steps in participatory extension

C. Working with groups in participatory extension:
   - The art of group facilitation
   - The secrets of successful facilitators
   - Reference groups and demonstration groups

D. Participatory planning of extension campaigns:
   - Working with problem trees
   - Working with Logical Frameworks

E. Participatory monitoring:
   - Monitoring and monitoring indicators
   - Participatory monitoring techniques

Dutch and Chinese experts worked jointly on the development and implementation of a farm monitoring system and on a suitable approach for the extension system, sometimes in smaller groups, sometimes with the whole team. The major project goal with respect to extension was to develop a more client oriented, participatory approach for extension in Tianjin. The current extension activities

are mostly focussed on top-down transfer of technical knowledge. After the first project year the general conclusion of the Dutch experts was that the technical results were mainly good, taking into account that it was the first year that the growers at TADC and Xinkou town grow Dutch varieties, but that far better results are possible. At the start of the project it was assumed that growers in the project area would be reluctant in adopting the new technologies from the Netherlands and that it would be necessary to set up a series of demonstration activities. It appeared, however, that the growers in general are very open for innovation and that the bottleneck in the development is more the lack of skills and knowledge with respect to crop management. Missing “green fingers”(i.e. skills in crop management) at TADC was considered as the weakest link in the Tianjin Vegetable Supply Chain. For that reason it was decided to focus the project activities more on strengthening the vegetable production capacity at TADC and less on institutional building.

The crop management training programme started in October 2001 with a training of three days at Rijk Zwaan Demonstration Centre in Qingdao with 9 persons from Tianjin; three persons from TADC, three from Xishuangtang, two from Liu Fu and one of Dang Cheng. Besides Rijk Zwaan experts the China Agricultural University of Beijing and Shenyang Agricultural University contributed to the training. A major part of the course was spent to cultivation techniques.

In 2002 Rijk Zwaan staff visited Tianjin almost once in a month for on the spot advise to the growers. During one of the visits they gave lectures pest and disease control, cultivation techniques and soil treatment to about 50 representatives of different counties and villages in Tianjin. In April 2002, a delegation of TADC went to Shouguang (Shangdong Province) to visit a large horticultural fair, the demonstration centre of Rijk Zwaan and growers in that region. The group consisted of junior and senior staff of TADC, working in cultivation or marketing. The visit was organised and guided by Rijk Zwaan and considered to be very instructive, not only with respect to cultivation techniques, but also with respect to marketing because of several meetings with traders at the wholesale market and at Rijk Zwaan's demonstration centre.

On-the-job training for TADC junior experts in Qingdao and Shouguang was planned but did not take place through cultivation problems in Qingdao and because the junior staff could not be missed at TADC.

Although TADC itself had not yet mastered the cultivation problems, the centre started to intensify its extension activities along side its commercial activities. The centre provided advice to growers who belonged to their network of suppliers, amongst others via the Tianjin Country Special Technological Confraternity (CSTC), for instance on cultivation techniques and the selection of crops and varieties. CSTC is an association of production associations, demonstration centres, extension services and research institutes and governmental institutions at county and local level. Senior experts of TADC started also to visit interested farmers groups of companies for the introduction of Dutch vegetables, wrote articles on Dutch vegetables in a weekly Magazine on Science and Technology. Copies of these articles are available for interested farmers. These activities, however, were mostly organised in an ad-hoc way and did not fit into a well-considered framework. The Dutch project team advised TADC on the development of extension material for growers. An extension brochure was ready in the summer of the second season (2002). The contents, however, is rather general (41 crops on 36 pages) and misses the required practical information for farmers on how to cultivate modern crops in greenhouses.

Hundreds of people visited TADC to make acquaintance with the modern facilities, most of them students and school children, but also farmers, staff of private companies and high officials dealing with agricultural and rural development.

3.5 Major Conclusions on extension in Tianjin

Despite these efforts and the progress made during the project, it has to be concluded that the knowledge and information system in Tianjin with respect to vegetable growing can be improved a lot. At one side the specific knowledge with respect to vegetable growing should be further deepened, while at the other side the available knowledge should be shared more broadly (broadening and deepening).

TADC is expected to play a leading role in the modernisation of the agricultural development in Tianjin, but the centre itself still misses the required expertise and knowledge. TADC does not yet have a well-structured extension, research and demonstration system and has not yet clearly determined and balanced its different functions. Most of the activities show an ad-hoc approach. The expertise for developing a professional extension curriculum and training material is not available and the staff needs additional training in crop management in order to eliminate the lagging skills and knowledge in the field of vegetable growing. The test and research capacity at TADC is also very limited. It is recommended involving other institutions in this type of activities to achieve an exchange of knowledge with respect to technical and economic aspects of sustainable (pollution free) vegetable production.

Box 2. Life cycle analysis

The introduction of a modern market oriented vegetable supply chain in Tianjin comprises many aspects in the field of marketing, production, extension, demonstration and research. This type of big projects have always ups and downs in particular at the start, some things are going right and others badly. This process is comparable with the introduction of new products (industrial and others as well) in the consumer market. This process has been investigated very well and the results of these investigations show that it is very difficult to introduce new products in the market. In spite of all the efforts, including market research, an average of eight out of ten newly introduced products fail to get a good position in the market. If the introduction is successful, the demand will grow fast and give the producer to expand his production. In that phase the market is "elastic", meaning that an increase in supply does not much influence the market price, resulting in relative high profits. After a certain period, different for different products, the market becomes saturated, the demand will decrease and the producers have to introduce new products. The "life-cycle" of a product consists of three phases:

- the introduction phase
- the growing phase and
- the saturation phase

The "life-cycle" concept is a well-known method to determine the status of a product in the market but it is also very useful for evaluating the status of large projects like the introduction of modern crops in Tianjin. The most difficult phase is the introduction phase. After that the development will go more smoothly, but first you have to overcome the starting problems, which arise manifold. You have to learn from your mistakes. That is one of conditions for success.

4 THE EVOLUTION OF THE GREENHOUSE HORTICULTURE IN THE NETHERLANDS

4.1 Introduction

How to establish a successful greenhouse horticulture sector? That is one of the challenges of the Tianjin government. The evolution of the greenhouse horticulture in the Netherlands may serve as an example, because it showed an impressive development in the last fifty years. The knowledge system played a dominant role in this success story. The technical, economic and social circumstances changed a lot during this period and in accordance to these developments the Dutch knowledge system focussed on different subjects during this period and took different positions in the development process. The subjects and positions concerned will be specified in this chapter. The review of 50 years greenhouse horticulture in the Netherlands will illustrate, that the limiting factors for the development of the greenhouse sector differ from time to time. The importance of a good organized network around the grower, especially at the start of the evolution, will be described.
In the following chapter the position of the greenhouse industry in Tianjin on the development path of the greenhouse industry in the Netherlands will be analysed. This analysis will lead to the formulation of recommendations for improvement of the knowledge system in Tianjin.

4.2 Productivity, engine of economic development

The continuous productivity growth in the Dutch greenhouse industry resulted in low costs per unit, in fact in a reduction of the cost price per kilogram in real terms. This advantage was, generally speaking, passed on to the consumers, so that they could buy good quality tomatoes for a lower real price. This productivity growth was realised by two main factors, viz. increasing the yield per m2 and decreasing the costs, in particular by lowering the labour input per square meter of greenhouse. Without this growth in productivity the cost price should have been more than 10 times higher as it is today and the greenhouse industry in the Netherlands should not even have existed. Productivity is, indeed, the engine of economic development and increasing the yield per square meter will also be essential for the development of successful greenhouse horticultural sector in Tianjin.

Some figures. In the 1950s the yield in greenhouses amounted to 7 till 8 kg tomatoes per square meter on a year basis. The average farm size was about 3,500 m2 under glass. Most of the farms were family farms, managed by father and son. Nowadays, the yield harvested per square meter is nearly 60 kg tomatoes (round tomatoes) on a year basis. The tomato seedlings are planted in the greenhouses in December, the harvest starts in March and ends in November. The farm size is now 15,000 square meters on average, with four permanent workers and the farmer uses additional casual workers in peak periods. Compared with the fifties, the farm size increased more than four times while the labour input increased less than 2.5 times per farm. Not only the production increased spectacular but also the consumer (being the king in the demand-driven economy) asked also for a larger variety of tomatoes like beef tomatoes (54 kg per m2), tomatoes on the vine (46 kg per m2) and cherry tomatoes (22-25 kg per m2). Other important crops in the Dutch greenhouse sector are the large type cucumbers (2 till 3 times inter-planted) with a yield of about 140 pieces (nearly 70 kg) per m2, and sweet peppers with 26 kg per m2 per year.

4.3 Phases in development

In the development of the Dutch greenhouse horticulture several successive phases can be distinguished (Buurma, 2001), corresponding with specific socio-economic circumstances and institutional changes. In order to address the actual constraints in the technical and economic developments in each phase, the Dutch knowledge system needed accordingly to focus on different subjects and to take different positions in the development process. The implicit goal of the knowledge system was and still is, to build up a population of growers with high competence in crop and farm management.

Table 4.1 Keywords for socio-economic situation, technological spearheads and strategic partners in successive phases in Dutch Greenhouse development

Phase	Initialisation	Mechanisation	Digitalisation	Integration
Period	1950-1965	1965-1980	1980-1993	1993-2000
Socio-economic characteristic	preparation of resources	fast economic growth	Information technology	demand-driven economy
Keywords for technological spearheads in horticulture	- fertilisation - pests/diseases - new varieties - growth regulation	- heating - interplanting - energy saving - labour efficiency	- climate computer - substrate culture - CO2-application - biological control	- pesticide reduction - product quality - certification - supply chains
Strategic partners for development	Primary producers	suppliers of fixed assets	suppliers of digital equipment	market/chain partners

Source: J.S. Buurma

The first phase in the greenhouse evolution in the Netherlands, from 1950 till 1965, was a period with a very low productivity. As has already been mentioned only 7-8 kg tomatoes were harvested per square meter of greenhouse per year. In that period the knowledge system acted as trouble-shooter and problem-solver of the primary producer (farmer). The major focus was on fertilization, irrigation, growth regulation, pest and disease control in soil and plants and the developing of new varieties. In this period the government was very active in extension, research and education. The extension to the individual farmer was provided free of charge.
In the period 1950-1965 the Dutch growers used a low level of technology. There was no drip irrigation; the growers used movable rubber tubes for watering the plants. The greenhouses were of low quality, single span and multi-span greenhouses ("Westland-type" and "Venlo-type"). The multi-span greenhouses were constructed of wood. The greenhouses were not heated. Climate control was very simple, by means of opening and closing some roof windows, by hand. All cultivation activities were carried out manually; there was no mechanisation and automation. The internal transport was also done manually. In that period the growers used mainly organic material for fertilisation and a limited amount of (chemical) fertilizers. The crops were rather sensitive for diseases and pests at that time. The most limiting factor was the lack of knowledge on the crop. Little was known on the behaviour of the plants, for instance on how they react on different growing circumstances. At that time the growers did not talk about the equilibrium between vegetative and generative crop development. It was not an issue in that period, as it was later. Most cultivation measurements were taken by trial and error. The big advantages of monitoring and measuring growing factors and growing conditions were not known. There was no thermometer in the greenhouse and soil analyses were only incidentally carried out. All farm activities were based on past experiences, knowledge transfer from father to son, without a scientific underground, physical measurements and data.

In the following phase from 1965 till 1980 the evolution took place from unheated, via lightly heated to strongly heated greenhouses. In unheated greenhouses tomatoes were planted in April/May and harvested from end June till middle of September/beginning of October. In the winter period the farmers mainly grew lettuce, one or two crops of lettuce successively. The crops were kept free of frost by simple stoves. The European market was very attractive for early tomatoes at that time. Farmers got very high prices and they were eager to harvest earlier. They therefore started to plant earlier, which was only possible by heating the greenhouses. Fruit-vegetables are all sensitive for low temperature; especially sweet peppers suffer quickly under cold-stress. At the start the extra heat was brought into the greenhouses with air-heating systems or a two pipe-heating system (two iron pipes per span of 3.20 meter). In the seventies the system moved to 4 pipes and even 5 pipes of 51 mm diameter per span. The Dutch grower, nowadays, can keep the temperature in the greenhouses at 16-20 degrees Celsius, day and night, the whole year round, even by severe frost. The heating capacity is about 240 Watt per square meter of greenhouse and fits to the Dutch climate circumstances, which is humid and has a temperature regime with few extremes. As a result the planting date is now end of November/beginning of December and the tomato harvest starts in March and ended in November. It is not possible to grow in the Netherlands tomatoes in the months December, January and February. The reason is lack of solar radiation. The light intensity in this period of the year is too low for the generative development. Light is the most important growing factor. The largest supply of Dutch tomatoes is in the summer time, from June to August, this is the period with the highest radiation. This is also the situation in Spain, also located on the northern hemisphere, but the temperature is much higher so that it becomes too hot in the greenhouses and the crops are suffering of heat-stress, resulting in low yields and low quality. In the winter period, however the radiation in Spain is sufficient for generative development, so that the Spanish growers produce most of the greenhouse tomatoes in

that period. In spring and autumn there is an overlap in production in Spain and the Netherlands, resulting in severe competition between Spanish and Dutch growers.
The Dutch growers use as a thumb-rule that 1% more light is 1 % more production. That is the reason that the innovation in greenhouses was fully focused on improvement of light transmission. The introduction of new types of greenhouse with only a few percentages of better light transmission resulted in a much shorter payback period of those greenhouses. Nowadays the multi-span greenhouses are constructed of thin aluminium sections. The single span greenhouses are disappeared because of an unfavourable cost/benefit ratio.

In order to survive the Dutch growers needed to follow drastic changes in the marketing system during the last ten years. They were used to bring their products to a vegetable auction, which took care for selling. Now the growers have (partly) to take care of the market themselves and to work according to the requirements of the supply chain. They have to follow key developments in the market, recognising consumer trends, and the introduction of private product labels. Good examples of these changes are the developments at Rijk Zwaan (see Doldersum, 2002). Ten years ago, this Dutch seed company had only direct contact with growers and propagation firms (i.e. nurseries who propagate seedlings for other growers) to sell its seed. At the moment Rijk Zwaan is working together with a group of growers and the supermarket “Co-op West-Switzerland” in Basle and does a lot of promotion activities in Switzerland to introduce Salanova, a lettuce novelty of Rijk Zwaan. The whole campaign is planned carefully with the retailer and the growers, including, for instance, the quantity of Salanova lettuce to be produced, the period of production and the logistics. A group of growers in the Netherlands is selected to produce Salanova. These growers are organized in a producer organisation. They are obliged to follow the instructions of Rijk Zwaan and Co-op West-Switzerland. They monitor and record the developments in their greenhouses, including many technical data, and visit each other's farms frequently to discuss aspects of cultivation and marketing. Rijk Zwaan organizes this all. The company, nowadays, is involved in the whole chain and plays an important role in supporting the growers in adapting the cultivation techniques to the wishes of the buyers. Other well-developed private labels are for example “Growers Bests”, a tomato on vine, of the supermarket chain Edeka (Germany), and Romaatje, a small tomato in a special package, of the supermarket chain Albert Heijn (The Netherlands).

In the period 1950-1965 the Dutch government was strongly involved in the development of the horticultural sector in particular trough education, research and extension. Some ten years ago several governmental organizations were privatised, like the "Agricultural Extension Service (DLV)" and the “Department for Agricultural Research, (DLO)” of the Ministry of Agriculture. Till that time the extension workers and researchers were fully paid by the Ministry of Agriculture and the extension was given free of charge to the individual farmer. Nowadays the farmers have to pay for the extension services. In most cases they have a contract with the privatised organization or with another private extension company. As by contract the extension worker is visiting the farmer periodically.

Farming is not a steady state but an ongoing process. The farmers need to adapt their farms to the changing financial, economic, social and political circumstances, amongst other things by increasing the size of the farm, intensifying of production process and mechanisation. As a result they have a great demand for capital. The Dutch government has always played an important role in the agricultural capital market through a number of policy instruments, such as the Agricultural Loan Guarantee Fund, the Development and Reorganisation Fund and also specific tax facilities.
Today, the Dutch government is not so actively involved in the horticultural business anymore. The growers have to do the business themselves together with the suppliers of farm inputs and the buyers of the output. The government is more involved and directly active in food safety and environmental issues related to the greenhouse culture, amongst others with respect to the reduction of pesticides and other agro-chemicals.

There is, of course, much more to tell about the evolution of the greenhouse industry in the Netherlands, but in the following sections we will concentrate on the transfer of knowledge.

4.4 From growers' network towards centre-function

The period 1950-1965 the whole horticultural sector in the Netherlands, including growers, extension-workers and researchers, were working getting the basic elements of the growing process on a higher level. The basic elements are soil, water, fertilisation, pest and diseases in relation to crop development. The whole sector strategy was focused on the grower. He was just like a spider in its web, the centre of a network of relations. In this network the study clubs and the extension-worker played an important role. A study-club is little group of 6-8 growers, all cultivating the same crop, visiting each farm periodically to discuss the development of the crop, the problems, possible solutions and the results. The extension worker supported the study-club, for instance by making the appointments for meetings and defining the agenda, in consultation with the members of the club. The extension-workers discussed the findings of the study clubs with researchers on experimental stations. In this way an intensive exchange of knowledge was arranged among growers and from growers to researchers and reverse. In addition the extension-workers wrote articles in specialised farmers' magazines and organized meetings with different groups of growers on all relevant topics, mostly in the evening and outside the peak times like the harvest-season. In this way the newly acquired knowledge could be disseminated rapidly to an expanding group of growers.
The whole process was organized bottom-up. In China, in general, a top-down approach is followed and decision-makers, researchers, extension workers and growers are used to that. However, an increase in productivity like in the Netherlands, from 7-8 kg tomatoes per m2 in the fifties to 60 kg now, can only be achieved trough a process of permanent self-education of the growers. Such a productivity growth cannot be reached by instructions from above. Of course, the researchers and extension workers need to teach the growers on the results of scientific work, but they should carefully listen to the growers to understand their problems in practice and to find solutions in consultation with them. In that way a dynamic process of creativity at the level of the growers can be initiated, like it was in the Netherlands. There are always growers who find new ways to continue this evolution process.

Centre function

The growers in the Netherlands had relatively easy access to capital, in particular from the co-operative agricultural bank and with government support. In the course of time professional suppliers of farm inputs, greenhouses, equipment, seeds, etc. came into development. They played a dominant role in development of the sector. The growers established co-operative auctions, which took all responsibility for marketing. In the course of time these local auctions merged into large regional auctions that governed the whole vegetable supply chain in the Netherlands. Recently the vegetable auctions have changed their marketing approach from the Dutch auction system into direct trade. Leading growers are active in all sectors of the society and represent the sector for instance in the board of auctions and other organisations. In the network around the growers in the Netherlands specialized magazines, with specialised journalists, were very active.
The whole set of organisations and activities around the growers in a region is called “Centre-Function”, meaning that the infra-structure is well developed, the growers have a great influence on the development and the information and knowledge transfer is optimal. All parties are creatively involved in the further development of the sector.

The most famous greenhouse district for vegetables in the Netherlands is the Westland, between The Hague and Rotterdam. Before World War II the Westland was very famous for its excellent table grapes cultivated in greenhouses. However, the cultivation reached the limits of productivity growth. As a result the cost price per kg of grapes increased dramatically, and the Westland grape lost the competition with the outdoor grapes from southern Europe. The dominant position of the (blue) grape was taken over by the (red) tomato directly after World War II. At the same time another greenhouse district, close to the Westland, The Kring, became famous because of its high quality but relatively cheap cucumbers. Another well-known greenhouse district is located in the southeast of the Netherlands, in the province Limburg and was famous for turnip cabbage/kohlrabi and very fine gherkins cultivated in greenhouses. Each above mentioned district had a well functioning centre-function, each focussed on the specific crops in the respective region.

5 IMPROVING KNOWLEDGE TRANSFER IN TIANJIN

5.1 Comparison of Tianjin Horticulture with the Dutch

The current situation in horticulture in Tianjin shows striking correspondences with the situation in the greenhouse sector of the Netherlands in period 1950-1965. Growers are struggling with fertilization and irrigation problems, pests and diseases and have difficulties with growing new varieties. These are the main factors that limit efficiency growth in Tianjin at the moment. The knowledge system of Tianjin should concentrate on these factors, gather the relevant knowledge on these topics and improve the information flow to the growers. In that way the productivity in Tianjin can substantially be increased. After that other technological spearheads in horticulture like heating, labour efficiency, substrate culture and CO2 enrichment can be dealt with in the process to higher yields. High-level yields like in the Netherlands can only be achieved with optimum temperature in the greenhouses, soil substrate (like rock wool) and extra carbon dioxide.

The big advantage for growers in Tianjin compared with the Dutch growers 50 years ago is that they can make use of technologies that have been developed since that time and the accumulated knowledge. They can grow modern varieties, for instance varieties that are less sensitive for pests and diseases and have a high yield-potential. They have the possibility to reduce the use of agro-chemicals by using more effective agents, following more precise control/monitoring systems or (even) working with biological control systems. They can use automatic fertilizing systems with drip irrigation to reduce water and fertilizer use and (simple) climate control systems to improve crop management. Generally speaking these technologies are available and the knowledge as well, but it will necessary to introduce these new technologies to the growers and to pass on the knowledge to them. That is the major challenge for the researchers and extension workers in Tianjin.

5.2 Green fingers

The term “Green fingers” does not refer to the dirty green hands you get by pruning tomato plants or harvesting tomatoes, but to the skills of the grower, the way he is capable to manipulate the plants on the basis of his knowledge, expertise and creativity. There are big differences among growers; one grower can manipulate the crop much better than another grower resulting in quite large differences in technical and economic results.
Growing fruit vegetables in greenhouses is quite different from growing them in the open field. Plants of greenhouse crops need to be manipulated over a relatively long period and also the period of harvesting is relatively long. In order to get good results it is required to realize equilibrium between the vegetative and generative development of the plants. The farmer has to observe the plants carefully and take the right decisions in all growing aspects, like soil tillage, watering, fertilising, topping and pruning, pest and disease control, greenhouse climate, etc. He also needs to react or anticipate on factors that he cannot manipulate like the weather. All in all he needs to have green fingers to achieve the best technical results. A farm, however, is an economic activity so that a farmer needs also to take into account all relevant economic factors. Crop management is only one aspect of farm management and that cannot be learned from textbooks or theoretical courses. It needs a long period of practical work. In the Netherlands young growers follow several years of specialised horticultural education, at least at primary and secondary level, have several years of practical experience on the parental farm or elsewhere and only then they are ready to take over a farm or to start a new one.

The junior staff of TADC who are responsible for the co-ordination of the day-by-day activities in the greenhouses at TADC, are well educated, they are graduated at the Agricultural College but they do not have much practical expertise. They do not have "green fingers" yet and that is not compensated by the knowledge and expertise of the senior staff. As a result the yields at TADC are rather low.

The lack of green fingers at TADC does not only cause a negative effect on the commercial results of TADC itself, but also of the results of the growers in the region because TADC can not fulfil its demonstration and extension task in a proper way. The current extension activities are not professionally organised and the extension material is rather basic, while the growers in Tianjin need information based on practical experiences. They do not have the required knowledge and expertise

for growing modern green house vegetables and the available extension by TADC and other institutions is not sufficient to overcome this weakness. That is the major limiting factor of the vegetable sector in Tianjin at the moment. With view on the increasing competition in the vegetable market, it urgently needed to solve this problem at short notice. It is, therefore, highly recommended that the decision-makers in Tianjin give high priority to this issue and develop a clear sector strategy including an overall extension plan.

5.3 Sources for getting "green fingers"

The library of TAAS is well provided with many books on crop management in vegetable cultivation and the junior staff of TADC makes use of it almost every day. But that information is rather general. For example: TADC has three types of greenhouses: a French multi-span greenhouse, traditional Chinese sunlight greenhouses and plastic covered walk-in-tunnels. Each type has its specific greenhouse climate, differently reacting under the changes of the outside climate and with different influences on the crop. However, practical literature about that is not available, there is no information on possible differences between a greenhouse of 3 or 6 meters high. Other information on factors directly related to the practice is also not available, like information on soil or other growing mediums, water quality, fertilizer quality, seed quality, spraying equipment etc. That information, however, can be acquired easily, because there is a lot of professional literature available on the practice of modern crops in greenhouses in countries like the Netherlands, Belgium and the United Kingdom. That information should be collected by researchers of TAAS, translated and adjusted to the circumstances in Tianjin, so that it can be used as basic material for extension. The project provided that type of information, but is has not been used yet.

Box 3. Soil improvement

One of the reasons for the low yields in Tianjin is the poor *soil quality*. Most of the land is heavy clay, which is not a good medium for fruit-vegetables in greenhouses. It will take many years to improve this type of soil with organic material and sand. Easier and even better solution might be found in soil substitutes. For instance, in the period of 1950-1965 cucumbers in the Netherlands were cultivated on a thick layer of straw mixed with manure and some fertilizers, covered with a thin layer of light soil. Another example is the situation in Almeria, a famous greenhouse district in Spain. There is no soil available; the land consists mainly of rocks. After smoothing the original ground ("suelo original") a 20 centimetre thick layer of soil is put into the greenhouse ("suelo aportado"). The suelo aportado remains in the greenhouse during the whole lifetime of the greenhouse, i.e. 15-20 years. Above that 5 centimetre layer of manure ("estiercol") is added and above that a top layer of 10 centimetre of sand ("arena"). The used soil and sand is brought to Almeria from other regions in Spain. This system of applying extra soil, manure and sand is called "enarenado". Fruit-vegetables grow very well in this system. The major disadvantage of this system is the necessity to sterilize the soil/the growing medium every 2 a 3 years. That is mostly done with the very poisonous methyl bromide, because steaming the soil is too expensive.

Given the situation that Tianjin is stimulating the production of pollution free vegetables, it is recommended to look at other soil substitutes like picon, perlita, sand or sacks with peat. What material most suitable is for cultivation medium in Tianjin depends on the availability of different material, the (transportation) costs and whether the material is easy to handle or not.

However, like it has been said before, you do not get green fingers from books, practical experience is necessary. It is essential to work with modern crops under guidance of professionals. These are available in China, for instance at the demonstration centres of Rijk Zwaan and other seed companies, in particular in Shangdong province. Following the initiatives of the project TADC should continue arranging short courses for their staff at these centres or and inviting them to visit TADC to give guidance to their staff and to other specialists and growers in Tianjin.

In addition to that one or more junior staff of TADC should spent a period of some weeks at least at the demonstration and growing centres of Rijk Zwaan or other companies to experience the day by day practice. Another possibility for training in practice provides the Sino-Dutch Horticultural and Demonstration Centre (SIDHOC) in Shanghai. There are also possibilities to get practical experience abroad, i.e. on farms in the Netherlands or to invite people with practical experiences or knowledge from abroad for lectures or practical courses.

Another interesting and effective source of useful practical experiences are the growers in Tianjin themselves. It is quite sure that there are a number of growers that have had success and profit in growing traditional varieties with traditional techniques. These farmers have in fact "green fingers". An indication for these growers can be found in the results of the farm monitoring system. The results, presented by Corré at the final seminar in Tianjin, show for each crop the variation in yields around the average. For cucumbers, for instance, the lowest yield was 5,5 kg per square meter and the highest 8,0, a difference of 45 %. These differences appeared not to be related to differences in inputs but in management. The growers with the best results should also be invited to form a growers group, a study-group on new technologies in vegetable growing.

5.4 Study clubs

Study clubs played and still play an important role in the knowledge system in the Netherlands. A study club is a group of farmers that produce the same crop and share their experiences by visiting as a group each other's farm to discuss their problems and possible solutions at the spot. In general the groups consist of 8-10 growers. They are assisted by extension workers who, for instance, organise the meetings and take care of the reporting and dissemination of the findings of the study clubs. In consultation with the growers, specialists are invited to attend the meetings of the group in order to address specific topics. Study-clubs play an important role in the knowledge transfer in the bottom-up line. They provide the opportunity for researchers and extension-workers to keep posted on the day-by-day problems the growers face in practice. They can also learn a lot from the leading farmers in the group, the innovative farmers. These so-called "early adopters" play a very important role in the evolution of the greenhouse industry, especially with respect to cultivation techniques. Study clubs play also an accelerating role in the processes of knowledge dissemination in the farmers' society, because each member of a study club communicates his findings with his relations in his business and personal network.

Figure 5.1 Frequent contact with farmers

In general the developments at the farms in the Netherlands are carefully monitored and the farmers keep detailed books on the technical and economic results. The monitoring and accounting data are excellent sources for getting more information on what is going on at farm level. The farmers in a study club use these data in their meetings to identify problems and to discuss possible solutions. The findings provide and excellent basis for extension material and help researchers to better formulate practice-oriented experiments

That system could also function in Tianjin. It is recommended to establish in Tianjin several study clubs, for each crop one or two study clubs, each with 8-10 growers. The members of a study-club have to produce the same crop. The farmers should visit each other member regularly, every two or three weeks, in particular during the growing season, to discuss the problems they face on their farms and the circumstances related to crop management. It is recommended to start with the leading farmers, the growers with green fingers. As it has been mentioned above the monitoring data could help in finding these farmers under the pilot demonstration farmers or the Pollution Free Vegetable Production Association in Xinkou town. The other farmers in the group but also extension-workers and researchers can learn a lot of these creative colleagues.

At the moment only the senior staff of TADC have direct contact with the farmers. Study-club activities offer great opportunities to bring the junior staff in contact with the daily practice at farm level. It is recommended that TADC takes the initiative for the establishment of these clubs and the organisations of farm and other meetings. The extension worker of TADC should also be responsible for the dissemination of the findings of the study-clubs, for example through staff meetings at TADC, meetings of larger groups of farmers and organizations like the CSTC. He should organise meetings of farmers not participating in study-clubs and visit with them farmers with good results. He should also write articles in relevant papers and magazines to reach a broader audience.

Box 4 Some cultivation guidelines, provided by Rijk Zwaan.

During the final seminar Mr. Hulisz, an expert of Rijk Zwaan, emphasized that modern vegetable cultivation ir greenhouses always requires the best quality: the best quality of soil, water, fertilizers and seeds, of course.
Soil quality is very important. It is recommended to use the best pieces of land for greenhouse cultivation. Instead of soil, a substrate can be used as growing medium, like it is standard in the Netherlands now. In the course of time the soil gets infected with diseases resulting in decreasing yields. It is therefore necessary to regularly sterilize the soil in the greenhouses. There are different possibilities: steaming, which is rather expensive, using chemicals, but that causes pollution, or solar treatment, which is done in tropic countries and may also be possible in Tianjin. TADC should test the different solutions.
Greenhouse cultivation needs the best quality of *water* available. Most Dutch growers use rainwater, which they catch from the roofs of the greenhouses in large basins, because the rainwater has a better quality than the groundwater or the water provided by the public water works. To judge the water quality the growers need to measure the EC and PH regularly.
The growers in Tianjin do not know enough about the water quantity that the plants need. In the summer a plant need for instance about 10 cups of water per day and in winter time only 1 cup. Most of the growers in Tianjin water the plants by flooding. They use different hoses and the one gives five minutes water and the other 15 minutes. Generally speaking the provision of water in the greenhouses in Tianjin is not optimal. The same goes for the application of fertilisers. The best way to improve that is to use a drip irrigation system. That is by far preferable above a flooding system. In combination with that the growers should use the best quality of *fertilisers,* i.e. fertilizers with a high contents of real fertilizers and a low sodium and chloride contents.
Very important is the *greenhouse climate*, in particular light intensity and temperature, which can be regulated by the quality of the plastic, the use of reed cover, ventilation and the greenhouse volume. Within the technical limits of the sunlight greenhouses the Tianjin growers can still improve the climate in their greenhouses.
The quality of the *seedlings* can be improved by using the best sowing medium (peat) to improve the nursery conditions and to make use of specialized nurseries. High quality *seed* is always expensive, but the high costs are compensated by high yields, one seed gives ten tomato bunches with about 60 tomatoes.
According to Hulisz the main points of attention should be: pesticide control (reduce the use of pesticides, follow safety restrictions, use the right spraying equipment, etc. with view on the food safety requirements in China and the export to markets like Japan), crop management (support from seed suppliers and via growers study clubs) and measuring and recording (temperature, water, yields). To grow fruit vegetables in greenhouses at a high level is a complex process, the final results depend on the right combination of all factors in the production chain: *the chain is as strong as the weakest link*.

5.5 Extension material

The monitoring data and the findings of the study-clubs can also help in improving the currently available extension material of TADC. It is recommended that TADC set up a series of short reports with “Best agricultural practices” with details on the cultivation of different crops. In addition to that is useful to publish periodical, e.g. a monthly farmers journal with articles with the results of tests in the Tianjin region, at TADC, local farms or elsewhere. These practical guidelines should be written by extension workers and researchers as well, from TADC and other institutions, at the beginning with the help of experts from outside Tianjin. Extension-workers should have an open mind in contacting other experts, especially from suppliers of inputs who often offer services to improve the production techniques at farm level. They should closely co-operate with companies like Rijk Zwaan.

As it is mentioned before a larger part of the extension material in the Netherlands is based on the data that are recorded by the farmers themselves in technical and economic monitoring systems. The farmers are very interested in the results of other farms and the conclusions that can be drawn from

the collected data. The always want to use that information, almost immediately, for the next crop; otherwise they will lose their interest. This causes always problems, because the researcher needs more time to compile the dataset, to analyse the material and to formulate the research results. The demand of the farmers can often be met by providing basic data as soon as possible during and directly after the season, for instance some tables with the differences between farms in yield per square meter in relation to the differences in planting data and the start/end of the harvesting period. This type of data, often presented in tables with data of similar farms, growing the same crop, are used by farmers in the Netherlands to discuss their results with colleagues of the study club and with extension workers. The data of individual farms are always presented in an anonymous way. The same type of information could be used in Tianjin.

5.6 Towards a professional extension service at TADC

As it has been mentioned before there are many institutions in Tianjin active in the development of the agricultural sector. The basic infrastructure for the development of a centre-function is available, but for achieving that the institutions should integrate their activities and combine their energy. A central place in the process of modernisation takes TADC with its modern facilities for production, marketing, testing and demonstration and specialised staff. The demonstration and extension activities of TADC, however, do not follow a strategic plan, but are mostly organised in an ad hoc way. In case TADC really wants to play the central role in the development of modern horticulture in Tianjin it will be necessary to focus its activities. Till now TADC is testing and producing a broad range of vegetables and started also growing flowers. That is interesting as a start but it will be difficult to bring the production for all these products at the required high technological level, because of the specific requirements of each crop. TADC, however, does not have the capacity to attract specialists for all these crops and, therefore, it is recommended that TADC makes a selection of vegetables (or flowers) on which it will focus its activities. Important selection criteria are the expected perspectives in the market and the experiences of the growers in the last two years.

In addition to that is necessary to establish a special extension unit at the centre, otherwise the demonstration and extension activities will always be subordinated to the commercial functions of the centre. The staff of the extension unit should consist of at least one extension worker for each selected crop, for example, one for cucumbers, tomatoes, sweet peppers and eggplant. In addition to that the centre should have specialist in certain aspects of greenhouse horticulture, e.g. in pest and disease control and farm economics.

These extension workers should not only be specialists in their field or crop but also have the required communication knowledge and skills. To build up a centre function, as the Dutch did, it is necessary that the extension workers adopt an informative rather than a persuasive approach in communication with the farmers, their clients. Communication skills should therefore be included in the selection criteria for hiring extension staff.

At TADC the staff combine many functions. Some of them are responsible for research, extension and demonstration and crop management as well. In the Netherlands these functions are separated at the experimental station. The crop manager is responsible for the crop in the greenhouses, only he and nobody else takes the decisions in the greenhouse to keep the crop in a good condition. The researcher is responsible for the experiments as such, the design of the tests, the procedures to follow and the measurements. He is responsible for data collection and analysis and for making the results public to extension workers and other interested persons. He should also have contacts with growers, but the communication with the farmers is not his first responsibility. That is the task of the extension worker. Together they can design the demonstration sites, at the experimental station or at pilot farms. It is recommended to TADC to follow a similar approach in which the responsibilities for the staff are clearer and it is possible for them to specialise in certain disciplines or crops. Given the lack of crop specialists at TADC specialization is preferable above job rotation.

The extension activities of TADC should be supported by research, for instance to test and show differences in inputs, outputs and treatment of different crops and varieties. The growers in Tianjin have problems caused by poor soil and water quality. It is recommended to carry out research to solve these problems. Test plots should be designed to analyse and show the differences in results of different technical systems, for instance differences in irrigation systems (flooding versus drip

irrigation), differences in the use of fertilisers (type and quantity). Tests can show the negative effects of salty water and salty fertilizers, the relevance of regular analyses of the soil nutrient status and the impact of differences in the plastic covers and reed mats on the solar radiation.
TADC should set up a number of experimental plots to show the growers the differences in results between old and new cultivation techniques. All these experiments could also be carried out at pilot farms. The tests should be set up by the researcher in consultation with the extension workers who know what problems are most urgent at farm level.

The research and extension by TADC should not be restricted to technological aspects of horticulture, but also include financial and economic aspects. Farming is an economic activity and therefore the farmers need to know whether their activities are profitable or not and what investments they need to take to stay in business. Is it profitable to buy the expensive hybrid seeds from abroad or is it more attractive to continue using the local varieties? TADC could make this clear by making economic calculations and showing differences in costs and returns, profit and losses for different crops, varieties, greenhouses, fertilisers, etc. These economic calculations are only possible under the condition that at least some farmers are keeping accounts and provide TADC with the required figures, like it was done during the project. In addition to that it will be necessary to include an economist in the staff, who is capable to analyse the data and explain the results to the extension workers and growers.

The extension unit need to design a professional extension and training programme, detailed for the coming growing season, more general for the future. Each extension-worker should establish a routine of extension activities, so that the growers and other involved people can count on it. The programme should include extension courses for growers, farm/field visits, meetings of study clubs, demonstration days at TADC, publication of articles and brochures etc. A perfect platform for transferring information and knowledge, bottom up and reverse, is the CSTC (Tianjin County Special Technology Confraternity) an association of small and medium sized agricultural and trade companies, research and extension organisations and governmental institutions. Through this association TADC can bring new technologies to the attention of extension services at county and town level and via them to the small growers. To strengthen its central function in the development of a modern horticulture TADC should further expand its network, for instance with local suppliers of farm inputs.
In that way TADC can help the Tianjin growers to overtake the arrears in practical knowledge and skills required for the development of a modern competitive horticulture in Tianjin.

Figure 5.2 Foreign and local experts

5.7 Summary of recommendations

1. The introduction of modern vegetable varieties in Tianjin has passed the second year. Like each big project with several aspects and parties it showed ups and downs in the introduction, failures and successes. New products have been introduced, new market partners have been contracted, the network of co-operating organisations has been strengthened, the production and demonstration facilities improved, but there is still a backlog in knowledge and skills in modern production techniques. The low level of practical technical knowledge is considered as a threat for the continuity of the whole modernisation process of the vegetable sector in Tianjin. Decision makers involved in this process should be aware of this weak link in the vegetable supply chain and take measurements to upgrade the level of practical cultivation knowledge and skills in the whole "Tianjin Greenhouse District".

2. A first step in that direction is the creation of a structured extension system, a routine for extension activities. Given the central role of TADC in the modernisation process it is recommended to establish an extension unit at the centre, a unit with qualified staff with the required technological knowledge and skills. It should be decided whether to continue with all fruit-vegetables (tomatoes, cucumbers, green peppers and eggplant) or to focus on a few very promising products. It is recommended to appoint at least one extension worker per selected crop. The extension workers should become specialist in integral crop management, so that he or she is capable to understand and to discuss with farmers and researchers as well, all technical aspects of a certain crop. These extension workers should adopt an informative rather than a persuasive approach to involve farmers in the modernisation process.

3. It is also recommended to review the organisation structure of TADC, in order to make clear the responsibilities of the staff at TADC. At the moment the responsibilities are mixed, which hampers the development of specialists in the different aspects of production, research, extension and marketing. Specialization is preferable above job rotation.

4. To acquire the required knowledge, books and courses are not enough, but practical day-by-day training is needed. To manage the growing conditions in practice is a complicated and difficult task. It is a prerequisite for the modernisation process that the TADC-staff get more practical experience, so that they get "green fingers". In addition to that useful knowledge need to be acquired, from Tianjin research institutes and experimental stations and, from other production centres in China or from abroad. It is recommended to tap all existing sources to improve the production knowledge and skills in Tianjin.

Figure 5.3 Demonstration and testing centre of Rijk Zwaan in Qingdao

5. One of the possibilities to acquire the required practical knowledge on modern cultivation techniques is to intensify the contacts with growers, extension services and demonstration centres in the province of Shangdong, one of the major vegetable production centres in China. Growers in that province have already a few years experience in growing modern varieties, amongst others with the help of Rijk Zwaan. It is recommended that TADC-staff (extension-workers, researchers and crop managers), in particular the junior staff, spend time with growers and demonstration centres in that region, preferably for longer period in order to experience the day by day practice. Another possibility offers the Sino-Dutch Horticultural and Demonstration Centre (SIDHOC) in Shanghai. Specialist from these and others expertise centres should be invited to Tianjin to give lectures and short courses for

deepening the practical knowledge of the staff of TADC and other extension services and via them the growers.

6. Outside China a lot of practical expertise is available on how to cultivate modern vegetable varieties. It is recommended to collect more professional literature focused on growing practices from abroad. In addition to that it should be considered to invite specialists with practical experiences from abroad. Young TADC-staff members could also work as a trainee at experimental stations or farms, for instance in the Netherlands.

7. It is especially recommended to start at local level a process of generating practical knowledge with all parties involved: extension workers, researchers, input suppliers and - last but not least- the growers in Tianjin. To raise the production from 6 to 25 kg tomatoes per m^2 cannot be achieved by a top-down transfer of technical knowledge; a participative approach is required in which all local parties involved work together, in a creative way. TADC should play a central role in that process by initiating and supporting different forms of co-operating. On the basis of the experiences in the Netherlands it is recommended to establish study-clubs, as an instrument for generating and disseminating knowledge. A study-club is a small group of farmers cultivating the same crop. It is recommended that the staff of the proposed extension unit at TADC takes the responsibility to organize these study clubs and their activities and take care of the dissemination of the findings.

8. It is recommended to create a complete structure for acquiring and transferring knowledge. Extension workers should regularly report about their findings in practice to all involved parties. They should write articles in magazines and papers about the problems in the field and bring forward solutions with the help of other specialists and researchers. The extension unit should organise meetings with the farmers and other involved parties, to discuss problems and possible solutions with other farmers and specialists from Tianjin or elsewhere. In consultation with the growers they could organise demonstration days for farmers on farms with interesting results.
Researchers are expected to set up trials that have direct relation with the problems the farmers face in practice and to present their findings on farmers meetings.
In order to reach as much as possible growers it is necessary to formulate explicit guidelines for modern crop management, to be published in “Best Farmers Practices” brochures for farmers. Farmers need to know what alternatives they have within the specific circumstances of Tianjin. They need to get information on soil and water quality, the available fertilizers and seed. They need to be informed on how to handle strict pesticide control in order to meet the requirements of Pollution Free Vegetable production. In short they need all the information for a profitable crop management, not in general but in detail for each crop. To provide that information is the major challenge for the research and extension institutions in Tianjin.

Box 5. Climate in relation to temperature

A characteristic of the climate in Tianjin is the hot summer and the cold winter. In January the average temperature is minus 8.3 °C, while the average maximum is only 1.1 °C. In July the average maximum is 31.5 °C and the average minimum 22.5 °C. In Spain the summers are also hot with in August an average maximum of 30.4 °C and an average minimum of 21.6 °C. The "greenhouse-effect" is about 5 °C, which means that both in Tianjin and Almeria the maximum temperature in the greenhouses is more than 35 °C for about 15-16 days per month in the summer. At these greenhouse temperatures crops, vegetables and flowers as well suffer a lot from heat stress. The Netherlands, however, have very mild summers, an ideal climate for fruit-vegetables in greenhouses. The average maximum temperature is only 21.9 °C in August and the average minimum amounts to 12.3 °C. For that reason the Dutch growers produce big quantities of fruit-vegetables (tomatoes, cucumbers, sweet peppers and eggplant) in the summer and that is also the main export period of the year.
Spanish growers make use of the mild winters and export lots of tomatoes during that period. The average maximum temperature in Spain in January is 8.1 °C and the average minimum is 16.8 °C.
In Tianjin production of tomatoes in the winter period is only possible with heating; the temperatures are too low in unheated greenhouses.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Tianjin (PRC)													
Max. Temp.	1.1	3.9	10.8	20.0	26.6	30.5	31.5	30.4	26.3	19.7	10.2	2.9	
Min. Temp.	-8.3	-6.0	0.0	7.7	14.0	19.2	22.5	22.0	16.5	9.1	0.8	-5.7	
Rainfall	2	3	7	21	31	64	170	150	45	18	9	3	525
Almeria (Sp)													
Max. Temp.	16.8	17.5	18.9	20.7	23.3	27.0	30.1	30.4	28.5	24.4	20.5	17.7	
Min. Temp.	8.1	8.5	9.8	11.6	14.2	17.7	20.8	21.6	19.6	15.7	11.9	9.0	
Rainfall	27	18	20	26	12	8	1	1	11	28	31	20	204
De Bilt (NL)													
Max. Temp.	5.1	5.8	9.2	12.5	17.1	19.4	21.6	21.9	18.4	14.0	9.0	6.3	
Min. Temp.	0.1	-0.1	2.0	3.6	7.5	10.3	12.5	12.3	10.0	6.7	3.4	1.4	
Rainfall	70	50	70	46	63	74	71	61	73	82	86	82	827

Max.Temp. = Average Maximum Temperature; Min.Temp. = Average Minimum Temperature; Rainfall in mm
Source: Tianjin: www.worldclimate.com; Almeria: www.inm.es; De Bilt: www.knmi.nl

Box 6. Climate in relation to solar radiation

The growth of a crop cultivated in a greenhouse is determined by the light condition, temperature, air humidity, CO2 concentration, irrigation and fertilisation. Light is the most important growth factor. Dutch farmers use the thumb-rule of 1% light is 1% production (Verhaegh 1980). The latitude primarily determines the light condition. Closer to the equator - or at lower latitude - will increase light conditions in general. Tianjin, Almeria (Spain) and the Netherlands are all located in the northern hemisphere. Tianjin is located at 39.10 N, Almeria (Sp) at 36.50 N and De Bilt (NL) 52 N. The Netherlands is located at high latitude and, therefore the light conditions in the winter are so poor that production of tomatoes without artificial light is impossible in the Netherlands. There is a deficit of radiation for generative development. The production of tomatoes in heavily heated greenhouses in the Netherlands under natural light conditions starts, therefore, in March. For Spain, however, the winter is very important period for the production and export of tomatoes. In the months November, December and January the quantity of light in Spain is more than 4 times bigger than in the Netherlands. That makes it possible to grow tomatoes, although the growers have to be careful in using all the light. Dirty plastic coverings of greenhouses, for instance, have a big negative impact on solar radiation, resulting in lower yields and quality of production. Tianjin is located nearly at the same latitude as Spain and it should, therefore, be very well possible to grow tomatoes in greenhouses in Tianjin in the winter. It is, however, in that period very cold in Tianjin, which is an enormous disadvantage for the growers in Tianjin. Spanish growers make use of the mild winter and produce tomatoes in unheated greenhouses, but it cost a lot of energy in Tianjin to create a favourable temperature in the greenhouses for growing tomatoes in wintertime. Only in case the market prices for tomatoes are very high it might be possible to get profits from a winter crop, taken into account that also the yields are relatively low because of the low level of solar radiation in the winter.

Average Daily Global Radiation (MJ per m2,d-1)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
De Bilt (Nl)	2.2	4.6	8.1	12.9	16.8	18.9	16.7	15.4	10.6	6.2	2.8	1.8	117
Almeria (Sp)	9.8	12.6	15.4	19.7	24.1	26.0	26.8	23.6	18.9	14.4	10.4	9.1	211
Source: Bailey 1988													

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