The purpose of the HORTIN-II programme was to contribute to the development of cost effective high quality value chains for vegetables and fruits. Among others this can be achieved when technology development takes place in close collaboration between public institutions, farmers and private companies.

On the Indonesian side the programme was carried out by the Indonesian Centre for Horticultural Research and Development (ICHORD), Jakarta, with the Indonesian Vegetable Research Institute (IVEGRI), Lembang, and the Indonesian Centre for Agricultural Postharvest Research and Development (ICAPRD) in Bogor.

In the Netherlands the Agricultural Economics Research Institute (AEI), Den Haag, the Agrotechnology and Food Sciences Group (ASFG), Wageningen, Applied Plant Research (APR), Lelystad, and WUR-Greenhouse Horticulture (WUR-GH), Bleiswijk, all partners in Wageningen University and Research centre, were involved in the programme.

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Executive Summary

Indonesia and The Netherlands share a long history of co-operation in horticultural research and development. On November 29, 2010, in Jakarta the second phase of the programme Horticultural Research Co-operation between Indonesia and The Netherlands (HORTIN) was concluded. The first phase was from 2003 to 2006. In this first period the activities focused on co-operation in research. In the second phase of the programme, emphasis was on co-innovation and development in the full supply chain, from production to marketing of horticultural products, in co-operation with small and medium enterprises.

The programme was executed in co-operation with private partners in the horticultural supply chain by staff from the Indonesian Vegetable Research Institute, Lembang, and the Indonesian Centre for Agricultural Post Harvest Research and Development, Bogor, and by staff of Wageningen University and Researchcentre, Lelystad, Bleiswijk, The Hague. At the Dutch side, the programme was financed by the Ministry of Agriculture, Nature and Food Quality (now the Ministry of Economic Affairs, Agriculture and Innovation). At the Indonesian side the Indonesian Agency for Agricultural Research and Development contributed to the costs, while also participating private companies contributed in kind.

For vegetables the activities concentrated on hot pepper, shallots and sweet pepper. For fruits, rambutan was the subject of the work (see below). In terms of area and number of farmers involved, hot pepper and shallots are the two major Indonesian vegetable crops. Consequently, innovations in the production of these two crops have major impact. Although a small crop for Indonesia in terms of area cultivated, sweet pepper was chosen as a third crop, because its production in plastic houses requires considerable input of technology. The Netherlands has expert knowledge on the production of sweet pepper under protected cultivation.

In co-operation with all actors in the supply chain the subjects for co-operation and the aims of the innovations were chosen. For hot pepper the work concentrated on the development of new production methods for lowland areas. With shallots, a new system was developed for the production of shallots from true seeds. With sweet pepper emphasis was on the development of improved plastic houses, on yield increasing and cost decreasing cultivation methods and on the implementation of integrated pest and disease control. For all crops the opportunities for improvements in the framework of the whole supply chain were investigated.

The results showed that the yield of hot pepper can increase considerably when the crop is cultivated in nethouses. Also pesticide use then seriously decreases. By cultivation in nethouses, the income of the farmer may increase almost three fold.

The use of new varieties of shallots, with plant material from seeds, may raise the farmer's income almost 1.5 times.

With the use of improved plastic houses, the right varieties, the optimum number of stems per plants and plant density, the income of sweet pepper growers may increase 1.2 to 1.8 times, depending on the facilities the grower has.

In the projects, all actors in the supply chains, such as individual farmers, farmers groups, small and medium agro-enterprises and supermarkets, have been trained in analyzing and co-operating in supply chains. By the active co-operation of farmers and other partners in these projects, a continuous direct and indirect transfer of knowledge took place. In the final year (2010), the activities concentrated almost fully on transfer of knowledge.

Through workshops, trainings, farmers field days on location and demonstration fields, the developed knowledge was transferred to a wide audience. The potential increase in income that can be realized by application of the innovations received a lot of attention.

Because from the start all actors in the supply chain were involved in the planning and execution of the activities, they co-directed the execution of the projects and contributed to knowledge and product development. Because of this process, the innovations developed are directly applicable by farmers. At the final meeting of the HORTIN programme it was concluded, that the methodology used should be institutionalized in Indonesian horticultural research and development.
Work on rambutan started in 2008 and concentrated on extension of the marketing season by processing and conservation of the fruits. The fruiting season of rambutan is rather short, with high prices at the start of the fruiting season, rapidly falling prices when trees come in full production and climbing prices when supply declines. Extension of the marketing season would increase farmer’s income. It has been shown that modified atmosphere packaging together with cold storage could extend the shelf life almost to 3 weeks. Processed rambutan can be stored at ambient temperatures (30°C) for 2 months, while rambutan juice can have a storage life up to 4 months. The technology to extend the marketing season of rambutan is now available.

The results show that by co-operation of partners in the supply chain and by introduction of already available knowledge and products through international co-operation, good results can be realized relatively fast. The four year period of the programme enabled the partners to learn each other well and this has contributed to the quality of the work.
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Visit to the Hortin-II project by Ms. G. Verburg (Minister of Agriculture, Nature and Food Quality of The Netherlands) and Dr. Ahmad Dimyati, (Director-General Horticulture of the Ministry of Agriculture of Indonesia).
Acknowledgement

We thank all farmers, Small and Medium Enterprises and companies who participated in the HORTIN-II activities. We hope that our collaborative efforts have helped them to build better businesses. We thank the Ministry of Agriculture, Nature and Food Quality, now the Ministry of Economic Affairs, Agriculture and Innovation, of The Netherlands and the Agency for Agricultural Research and Development of the Ministry of Agriculture of Indonesia, for financial support. We especially thank Mr. Hans van der Zijden, Agricultural Counselor at the Royal Dutch Embassy in Jakarta and Mr. Wil Huisman at the Dutch Ministry of Agriculture, Nature and Food Quality (now the Ministry of Economic Affairs, Agriculture and Innovation) in The Hague for their continued interest, dedication and support of the HORTIN-II programme from 2007 to 2010.
1. Introduction

1.1. Continued co-operation
Indonesia and the Netherlands have a long standing history of co-operation in the field of horticultural research and development. In the second half of 2006 the needs and opportunities were explored for continued bilateral co-operation in the horticultural sector. Beforehand the two countries had jointly formulated the following key principles for continued co-operation in the field of horticultural research and development:

- Impact is to be achieved at the level of Small and Medium Enterprises (SME’s);
- Co-innovation will be the leading approach;
- Private sector commitment and co-operation is imperative;
- Both countries will jointly contribute research and development capacities.

The co-innovation approach offers opportunities for understanding how Indonesia’s horticultural sector can make better use of new knowledge and can design alternative interventions that,

- go beyond purely research investments and;
- address practical demands and bottlenecks in supply chains.

The latter is important since most horticultural production is increasingly integrated in supply chains. A supply chain brings partners together in order to integrate production, marketing, and consumption in the most efficient and profitable way.

A summary outline for a follow up programme according to these principles was elaborated and the Working Group on Agriculture and Fisheries between the Ministries of Agriculture of Indonesia and the Netherlands approved the summary outline for future collaboration.

1.2. Inception of HORTIN-II
A comprehensive inception phase per crop / supply chain, including farmers’ and private sector consultation was planned and executed before the actual implementation of the research and development activities in 2007. The purpose of the new HORTIN-II programme and the differences with the previous HORTIN projects were explained in a number of meetings and discussions with stake-holders in Indonesia early 2007. Position papers on the three commodities, hot pepper, shallots and sweet pepper, were drafted. The HORTIN-II management team visited the major production centres of these three crops and conducted discussions with farmers, traders and input providers as well as Government staff. The field work was concluded with group discussions with growers of hot pepper, shallot and sweet pepper in order to systematically discuss and rank their problems and opportunities faced in the supply chain.

The inception phase was concluded with a one day ‘multi stakeholder’ workshop with representatives of companies, farmers and government officials. During this workshop a selection of projects was made and the concept of co-innovation was discussed, as well as the envisaged role of the companies and farmers in the programme. Proposals were finalized in the Netherlands in the period May 14 – 23, together with the Indonesian project leaders.

A major challenge of the programme was how to let SME’s and producers benefit from the innovations of applied research and development, while at the same time addressing practical demands and bottlenecks in the supply chain.

1.3. Objectives
The goal of the HORTIN-II programme was to attain competitive and sustainable vegetable supply chains and hence contribute to local economic development.

To address this goal the following purposes were formulated to be realized at the end of the programme:

- Collaborative research results in competitive and sustainable horticultural supply chains;
- The position of participating SME’s and farmers in supply chains has been strengthened;
- Capacity has been built with stakeholders on the co-innovation approach.

In this context the HORTIN-II programme was a pilot on how to make supply chains more competitive and to
empower farmers in markets by means of innovations and contributions from research and development.

The major focus of the HORTIN-II programme was on the vegetables hot pepper, shallots and sweet pepper. Hot pepper and shallots are the two major Indonesian vegetables in terms of area cultivated and number of farmers involved. Innovations in the production and supply chain management with these crops have major effects, both for farmers and consumers. Sweet pepper, being grown under protected cultivation on substrate, has a large technology component involved in its production, it has short and clearly arranged supply chains and it is a high value crop. These characteristics make the crop a good pilot crop for supply chain innovations.

1.4. Projects and intended impact
Six project activities were formulated and started in 2007:

* **Improvement of sweet pepper production technology to achieve competitive supply chains.**
  - Improved and innovative production systems of sweet pepper based on on-farm research.

* **Integrated pest management in sweet pepper.**
  - Sustainable sweet pepper production by using Integrated Pest Management strategies.

* **Improvement of shallots supply chains.**
  - Production of shallots from true seeds in order to make local shallot production more productive and thereby more competitive.

* **Hot pepper co-innovation development based on supply chain analysis.**
  - Sustainable production system of hot pepper production in lowland areas.

* **Quantitative Economic Analysis.**
  - Determine and increase awareness of the economic impact of the innovations on farm level.

* **Horticultural supply chain development.**
  - Identify and apply appropriate interventions based on supply chain analysis.

**Fruits**
In 2008 additional funds to improve fruit supply chains became available. In close co-operation with the Directorate Fruit Crops of the Ministry of Agriculture of Indonesia and local partners involved in fruit supply chains, a mission was carried out to identify potentially successful fruit supply chains, both for the domestic as well as the export market. Clear recommendations were made and as a result it was agreed to focus further efforts on rambutan. The main aim of the work would be to investigate opportunities for spreading the supply season by post-harvest treatments. A new project activity was formulated:

* **Product diversification and quality improvement of rambutan.**
  - Generate employment and income for rambutan producers by optimizing post-harvest treatments.

All seven projects continued until the end of the HORTIN-II activities in 2010.

1.5. References

1.6 Presentations
Horticultural Research Co-operation between Indonesia and the Netherlands HORTIN II
An introduction to the Workshop. Lembang, May 1, 2007
2. Results

2.1. Projects

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- P.T. East West Seed Indonesia, Purwakarta.
- Farmer group Mitra Suka Maju, Pasirlangu, Lembang.
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2.1.1.4. Aim of the project
The main aim of the project was to contribute to the development of an innovative, high value and cost-effective supply chain for sweet pepper by improving sweet pepper production in plastic houses in Indonesia. The objectives of the project were:
- Identifying the priority bottlenecks in the sweet pepper supply chain based on a participatory approach.
- Developing improved and innovative production systems of sweet pepper grown in plastic houses, to increase production and quality based on bottlenecks’ findings in the sweet pepper supply chain.
- Introducing techniques to farmers through on-farm research.
- Assessing the impact on farmers’ income by conducting an economic evaluation on both existing and new techniques.

2.1.1.5. Activities, results and realization
From several bottlenecks in the sweet pepper supply chain, three priority problems, or bottlenecks, were identified through field visits, surveys, field experiments, previous research project evaluation, group discussions and the inception workshop during the start of the HORTIN-II project. The three priority bottlenecks in the sweet pepper supply chain are: costs of seed/planting material, yield level and marketing. The low yield level in the production phase was selected as the main bottleneck that needed to be solved.

The price of the sweet pepper seed for the Indonesian grower is high and therefore causes high production costs in sweet pepper cultivation. In order to reduce the cost of seed, one method in the sweet pepper cultivation to reduce seed costs is by reducing the use of seed. By taken more stems per plant, the grower could reduce the use of seed. More stems per plant has, however, an influence on the earliness of production and on the total production.

Experiments
In 2007 two experiments, one at the experimental farm of the Indonesian Vegetable Research Institute (IVEGRI) at Lembang and another one at a sweet pepper farm in Pasirlangu were conducted in order to determine the effect of number of stem per plant on the growth and yield of three varieties of sweet pepper.
Another experiment with the objective of determining the effect of stem density on the growth and yield of sweet pepper under plastic house conditions in Indonesia was conducted at the experimental farm of IVEGRI. From the experiments the following conclusions were drawn:

- The crops grown with three stems per plant had a total yield and yield class > 200g, 9% higher than those with two stems per plant.
- The total yield and yield of fruits > 200g of variety Athena were significantly higher than those of variety Chang, but similar to those of variety Spider.
- The crops grown with four stems per plant and 11.2 stems/m² gave significantly the highest total production in number of fruits and weight per fruit.

In 2008 two experiments were conducted at IVEGRI and at a farmer’s farm in Pasirlangu. In the experiments the influence of differences in plant balance at the beginning of the cultivation was investigated. The experiments were done with a yellow fruit colour type (variety Sunny), green type (variety Spider) and one red type (variety Spider).

From the experiments the following conclusions were drawn:

- The plant balancing system did not significantly affect the total yields and yield of fruits > 200 g, although it was observed that the plant balancing system affected significantly the total plant height.
- The total yields and total number of fruits of variety Spider (harvested green) were significantly higher than those of variety Spider (red fruits harvested) and variety Sunny (yellow fruits harvested). The fruits of variety Spider (fruits harvested when still green) were smaller than the fruits of variety Spider (harvested red) and variety Sunny (harvested yellow).
- Differences in total yields were observed between experiments. In general the total yields of the experiment conducted in the wood-metal plastic house at IVEGRI were higher than those of the experiment conducted in the bamboo plastic house at the farmer’s farm in Pasirlangu.

In order to have a wider variety choice in sweet pepper cultivation and to determine the characteristics of each variety in combination with different stem densities on their effect on production, in 2009 an experiment was conducted at the experimental farm of IVEGRI with two, three and four stems per plant with four varieties. From the experiments the following conclusions were drawn:

- Plants with three stems gave the highest total yields and yield of fruit > 200 g compared to plants with two stems or four stems.
- Varieties Spider and Zamboni gave the highest yield.
- The results suggested that in order to obtain relatively big sized fruits, the varieties E 41.9660 or Zamboni should be recommended. For medium sized fruits, the varieties Spider or Inspiration are to be recommended.

**Workshops**

In order to disseminate the results of the experiments, in 2008 a workshop for sweet pepper growers was organized. In the workshop there were 57 participants. The main subjects of the workshop were:

- Results of the trials at IVEGRI and at Asep Tisna’s farm;
- A lecture on ‘Plant-balance in sweet pepper cultivation in Indonesia’;
- Discussion about the design of new trials;
- A lecture on ‘Control of pests and diseases in sweet pepper’.

A workshop to disseminate the results of the experiments conducted in 2007, 2008 and 2009 and to present the important factors involved in sweet pepper cultivation was organized at IVEGRI, Lembang on May 18, 2010. There were 53 participants.
Yield and fruit size is influenced by variety.

Different subjects of sweet pepper cultivation and results of the experiments were presented:

- **Water and nutrition.**
  - Difference between soil and substrate cultivation;
  - Different elements (deficiency and excess), pH and EC;
  - The amount of water and fertilizers.
- **Fruit setting and steering production.**
  - Structure of the plant and photosynthesis;
  - Source and sink relations, demand of assimilates;
  - Balance between vegetative and generative growth.
- **Sweet pepper cultivation in the Netherlands.**
- **Economic calculations in sweet pepper cultivation.**
  - How to calculate the greenhouse production;
  - Overview costs and income by using information from experiments at IVEGRI;
- **Handling of sweet pepper fruits in Indonesia and in the Netherlands.**

In the afternoon an excursion was organized with the sweet pepper grower’s co-operative of Pasirlangu. Two growers showed a new plastic house with good drip irrigation. The quality of the sweet pepper plants and fruits was excellent. The following subjects were further discussed: use of fertilizers and drip irrigation, pest and diseases, steering production, harvesting and handling.

**Sweet pepper demonstration cultivation at a farmer’s place in Pasirlangu**

The activities of the project in 2010 concentrated on transfer of technology. On three occasions trainings were given at a farmers’ location in Pasirlangu. While also the results of the research of the past years were discussed with growers and advisers.

Subjects in the training were:

- Higher production in plastic house with better light transmission.
- Different aspects of cultivation.
  - Varieties;
  - Number of stems per plant and per m²;
  - Optimizing the start of the cultivation;
  - Pruning of the fruits or plant-balance.
- Fertilization in the sweet pepper cultivation.
• Optimizing the amount of water.
• Pest and disease control/ biological control.
• Harvesting and post harvest handling.

2.1.1.6. Conclusions
• It is estimated that the production increases with 20% when using a wood metal plastic house in combination with the use of plant cultivation techniques developed in the project.
• From two experiments it appeared that with keeping three stems per plant the highest production was realized and costs of seeds were reduced.
• There are possibilities to raise the production further by an increase in stem density. Even with a stem density of 11.2 stems/m² the maximum production was not reached.
• In general it is better to allow fruit setting from node three onwards.
• In general the sweet pepper varieties Chang, Spider and Zamboni are suitable for cultivation in the highlands of Java.

2.1.1.7. Recommendations
It has been shown that it is possible to produce sweet pepper in Indonesia at high quantities and with a good quality. It is important that growers regularly organize excursions to sweet pepper production farms or plastic houses, during which they can discuss with researchers and advisers about the problems and progress in the sweet pepper cultivation.

2.1.1.8. Training, technology transfer and knowledge exchange
In 2008 and 2010 at IVEGRI workshops for sweet pepper growers were organized with 57 and 53 participants respectively. Three meetings at a farmers’ location in Pasirlangu were organized in 2010 at which different subjects were discussed. Experiments were carried out at commercial sweet pepper farms, as a result farmers were directly involved in the research and innovation.

2.1.1.9. Reports, publications
• Mission Report 1. Improvement of sweet pepper production technology to achieve competitive supply chains.
• Mission Report 12. Improvement of sweet pepper production technology to achieve competitive supply chains.
• Mission Report 25. Improvement of sweet pepper production technology to achieve competitive supply chains.
• Mission Report 31. Improvement of sweet pepper production technology to achieve competitive supply chains.

• Research Report 23. Effect of number of stems per plant on the growth and yield of four sweet pepper varieties.
• Research Report 24. Effect of plant balancing on the growth and yield of two sweet pepper varieties harvested yellow, green and red.

• Nikardi, G., Maaswinkel, R., Moekasan, T.K., Prabaningrum, L. dan Witono, A. Pengaruh jumlah cabang per tanaman terhadap pertumbuhan dan hasil tiga varietas (The effect of number of stem per plant on the growth and yields of three sweet pepper varieties). Jurnal Hortikultura (accepted).

2.1.1.10. Presentations
• Pengaruh jumlah cabang (2, 3 dan 4 cabang) per tanaman pada empat varietas paprika (IVEGRI). Workshop Results of the trials 2008, 2009 and several subjects about sweet pepper cultivation technique. Lembang, May 18, 2010.
• Pengaruh sistem kesimbangan tanaman (plant balancing) terhadap hasil dua varietas paprika yang dipanen hijau dan warna (IVEGRI). Workshop Results of the trials 2008, 2009 and several subjects about sweet pepper cultivation technique. Lembang, May 18, 2010.
• Cultivation, fruit-setting and steering production in Indonesia (Wageningen UR Greenhouse Horticulture). Workshop Results of the trials in 2008, 2009 and several subjects about sweet pepper cultivation technique. Lembang, May 18, 2010.
• Harvest and handling (Wageningen UR Greenhouse Horticulture). Workshop Results of the trials 2008, 2009 and several subjects about sweet pepper cultivation technique. Lembang, May 18, 2010.
The start is already important: plant arrangement and stem density affects yield.
2.1.2. Integrated pest management in sweet pepper (IPM)

2.1.2.1. Project leaders
- Nikardi Gunadi, Indonesian Vegetable Research Institute, Lembang, Indonesia.
- Laksminawati Prabangrum, Indonesian Vegetable Research Institute, Lembang, Indonesia.
- Tonny Moekasan, Indonesian Vegetable Research Institute, Lembang, Indonesia.

2.1.2.2. Executing agencies
- Indonesian Vegetable Research Institute, Lembang.
- Wageningen UR Greenhouse Horticulture, Bleiswijk.

2.1.2.3. Participating organizations
- P.T. ASB, Cigugurgirang, Parongpong, Bandung.
- Bank Indonesia, Kantor Cabang Bandung.
- P.T. East West Seed Indonesia, Purwakarta.
- Farmers group Mitra Suka Maju, Pasirlangu, Lembang.
- Horticulture Partnership Supporting Program, Jakarta.
- P.T. Joro, Bogor and Bali.

2.1.2.4. Aim of the project
To develop sustainable sweet pepper production by using Integrated Pest Management strategies (IPM) under plastic house conditions in Indonesia.

2.1.2.5. Activities, results and realization
One of the problems faced by the sweet pepper farmers in Pasirlangu village in Bandung Barat District West Java, the biggest sweet pepper growing area in Indonesia, are thrips and powdery mildew. Due to the very intensive planting this pest and this disease are very difficult to control. As a consequence the farmers intensively and excessively use insecticides and fungicides. This not only causes an increase in production costs, but also increases the amount of pesticide residues on the fruits, hampering export. Often, the sweet pepper product for export is rejected due to the limit exceeding levels of pesticide residue. Farmers who want to export are allowed to use a limited number of pesticides only. Improper application techniques often results in non-effective control of pests and diseases. Because of this limited efficacy, growers tend to use higher dosages than the recommended dosage of a pesticide, which results in high residue levels on the fruits. Lack of knowledge of pests and diseases and lack of knowledge of the mode of action of pesticides, are also factors influencing the results of applications. Because of these conditions, trainings were given to improve the knowledge on pests and diseases and on pesticides application techniques.

**Training**
IPM training has been conducted in 2007 – 2008 and was attended by 65 growers. The training has been carried out every week during a planting period of sweet pepper. The curriculum consisted of identification of pests and diseases, scouting and monitoring, control threshold, biological control, chemical control, cultural control and the use of a sulphur evaporator. Demonstrations with pesticide applications at farmer’s sites, using their own equipment have been conducted. The aim of this activity was to obtain the best efficacy in terms of pest control with a low use of pesticides. To help the growers to improve the application of pesticides, a manual for spraying techniques has been prepared.

**Biological control of thrips using predators**
The use of predators to control thrips is considered as the best method to reduce the excessive use of insecticides and also to reduce the high residue levels on the fruits.
In order to obtain a permit for importing predators experiments in line with the standard procedures from the bio agents’ commission on the use of predators was conducted.

- A laboratory and a field experiment to obtain the permit for importing the predators *Amblyseius swirskii* and *Orius laevigatus* have been carried out early 2008. The permit was obtained by PT Joro at the end of 2008.
- Demonstrations with biological control methods have been carried out at two locations (Pasirlangu and Cipanas) in 2009. In spite of the problems with other pests (caterpillars, aphids) and powdery mildew the growers are positive concerning biological control.
- A protocol for biological control of thrips with *Amblyseius swirskii* (predatory mite) and *Orius laevigatus* (predatory bug) has been made. The protocol consists of information about, (i) the number of predators needed to control thrips, (ii) compatibility of predator use with pesticide use, (iii), the direct, indirect and long-term effects of pesticides on the predators, and (iv), the effect of sulphur use on the predators.

**Results**

- Courses given have over the past years improved the growers’ knowledge on pests and diseases and pesticides.
- The growers learned how to scout and monitor pests, diseases and crop growth, as a result they can now detect in an early stage infestations of their crop and at the same time make decisions on the appropriate action.
- Providing the growers pest and disease thresholds levels for decision making on application timing and selection of pesticides.
- Demonstrations at farmer sites of pesticide applications with their own equipment, to show how to improve efficacy of applications have been carried out successfully.
- Sulphur, using evaporators, to control powdery mildew reduced the amount of fungicides used.
- To obtain a permit for importing the predators *Amblyseius swirskii* and *Orius laevigatus*, a laboratory and field experiment have been carried out. The permit was obtained by PT Joro the end of 2008.
- Demonstrations with biological control methods have been carried out on two locations.
- A protocol for biological control of thrips with *Amblyseius swirskii* (predatory mite) and *Orius laevigatus* (predatory bug) has been made.

2.1.2.6. Conclusions

In spite of the problems with other pests (caterpillars, aphids) and powdery mildew in the nurseries, where the demonstrations with the predators took place, the growers are positive concerning biological control. However, advice and assistance is still necessary before IPM in sweet pepper in Indonesia will prove to be successful. According to P.T. Joro the import of the predators from The Netherlands (Koppert B.V.) and distribution in Indonesia does not have to be restrictive in this.

2.1.2.7. Recommendations

The best way to reduce the use of insecticides is to stimulate biological control. A good start has been made with the permit for import of the predators from The Netherlands. Searching for locally occurring predators and parasites could be another option.

2.1.2.8. Training, technology transfer and knowledge exchange

- Presentations were held on chemical - and biological control of pests and diseases.
- Demonstrations on application of pesticides were given at farmer sites.

2.1.2.9. Reports, publications

• Study of effectivity of *Amblyseius swirskii* and *Orius laevigatus* against *Thrips parvispinus* on sweet pepper (Report on the laboratory and field experiment with biological control of thrips for obtaining the permit for import of predators from The Netherlands) (2008).


• Manual for spraying technique (2010).

2.1.2.10. Presentations

• Control of pests and diseases in sweet pepper/ Pengendalian hama dan penyakit pada tanaman paprika - workshop for growers, extension workers and researchers. Lembang, March 11, 2008.


• Control of pests and diseases in sweet pepper / Pengendalian hama dan penyakit pada tanaman paprika. Women of “Bali Fresh” Female Farmers Partnership (P.T. Joro). Bali, August 16, 2009.

• Control of pests and diseases in sweet pepper / Pengendalian hama dan penyakit secara kimiawi pada budidaya paprika. Growers and extension workers. Pasirlangu, June 30, 2010.

*Visit of Ms. G. Verburg to the sweet pepper project.*
2.1.3. Improvement of shallot supply chains (Shallots)

2.1.3.1. Project leaders
- Rofik Sinung Basuki, Indonesian Vegetable Research Institute, Lembang, Indonesia.

2.1.3.2. Executing agencies
- Indonesian Vegetable Research Institute, Lembang.
- Wageningen UR, Applied Plant Research, Lelystad.

2.1.3.3. Participating organizations
- PT East West Seed Indonesia, Purwarkarta.
- Farmers groups in Brebes, Nganjuk and Yogyakarta districts.
- Dinas Pertanian, Brebes.

2.1.3.4. Aim of the project
The aim of the project was to develop and test the production of shallots from true seeds (TSS: True Seed Shallots). The goal was to make local shallot production more productive and more competitive. Production of shallots from seeds was likely to result in considerably lower costs per unit of product. Optimal nursery and transplanting techniques needed to be developed under farmer’s condition and these techniques needed to be introduced on farms in different regions.

2.1.3.5. Activities, results and realization
In 2007, 2008 and 2009 research was done on different aspects of growing True Seed Shallots (TSS). Experiments were done in Brebes, one of the main shallot growing areas in Indonesia. There is a clear difference in growing techniques between TSS and shallots grown from seed bulbs. In TSS production seed is sown in nurseries to obtain seedlings and this is followed by transplanting seedlings in production fields. In traditional shallot production, farmers are planting seed bulbs. The research was focused especially on improving the nursery- and transplanting techniques of TSS. In the experiments two TSS varieties were used: Tuktuk, and a newly developed variety: Sanren. Both varieties were developed by East West Seed Indonesia (EWSI).

In July 2007 the project was started with an orientation on the possibilities to grow TSS in the local situation of
Brebes. Research was started with two experiments in which different nursery systems were tested: seedbed, trays, plastic bags, trays with compartments, single seedlings, clusters of seedlings on soil modules and press pots (made by compressing soil in a mold to form a soil cube). Also two transplanting experiments with 8, resp. 12 treatments were conducted: planting densities, single seedlings and clusters of seedlings on soil modules, with seed bulb varieties as reference. In September and December East West Seed Indonesia (EWSI) was visited to discuss the research topics and to agree on collaboration. Also the Crop Protection division of Syngenta was visited. In December a workshop was organized with farmers, traders and agronomists of the Extension service (Dinas Pertanian) to discuss the results.

The transplanting experiments in 2007 suffered from damage caused by Spodoptera caterpillars and from water shortage halfway the growing season. At the end of the growing season experiments were suffering from excessive rainfall. Therefore, reliable yield data could not be established, but the experiments and the discussions with the farmers and EWSI, made clear that nurseries sown on a seedbed in the fields, or on trays without compartments, were giving the best results. Production of clusters of seedlings on soil modules was not useful. Survival of individual seedlings after transplanting was good.

In 2008 research was continued with experiments on different nursery soil mixtures and research on different aspects of transplanting: TSS varieties, soil types, single seedlings or clusters of seedlings on soil modules and plant densities. Two transplanting experiments were conducted. TSS production was compared with production of traditional shallot crops grown from seed bulbs. Additionally, two direct sowing experiments were done. Time registrations of the different activities in growing TSS were done and also costs of materials were recorded. On 31 July 2008 a field day was organized on which the different treatments in the trials and the obtained results were presented to the farmers, exporters, local traders and agronomists of the Extension Service. Around 75-100 persons visited the field day. On 6 and 7 August 2008, farmers from different provinces of Indonesia visited the trials in Brebes. EWSI was visited two times to discuss the results and the research topics. Next to those activities, two experiments were performed by EWSI on different soil types.

The experiments of 2008 gave reliable results, because of the good weather. Dry season, enough water and a good wind (“angin kumbang”). The research on nursery mixtures made clear that mixtures consisting of sandy soil with 1/3 or 1/4 (volume) compost or stable manure were giving the best results. In the transplant experiments large differences in yield between TSS and seed bulb crops were measured. The yield of TSS Tuktuk was twice as high as the mean yield of the seed bulb varieties. A new TSS variety, Sanren, appeared to be an improvement of Tuktuk in terms of yield, earliness, disease resistance, grading and acceptance by the local market. The direct seeding experiments made clear that direct seeding is not a real option, because of weed problems and the high risks of young seedlings being destroyed by heavy rain and pests and diseases. In the workshop with farmers,
traders and extension agronomist, a good response was met. Several farmers now tried growing TSS, or they had visited the experiments. They were able to bring in their ideas about TSS production.

During the wet season of 2008/2009 a storage experiment was done in cooperation with EWSI. In March 2009 an experiment was started with different sowing times of the nursery, followed by a plant density experiment and a nitrogen fertilization experiment, both with two TSS varieties and a seed bulb variety as a reference. Two seed efficiency experiments were done: beds in the field, trays, sowing depths, normal seed, seed treated with Ridomil or Tracer, drenching with Previcure, different materials for closing the furrows and differences in water supply. In addition an experiment with differences in nitrogen fertilization of the nursery and differences in age of seedlings at moment of transplanting were done. Results were discussed with EWSI two times and in Brebes and in Nganjuk workshops were organized with farmers, traders and agronomists of the Extension service.

The experiments of 2009 were giving reliable results. However, the level of shallot production was relatively low in 2009, as was the case in traditional shallot production. It happened because during the growing period, dark and rainy weather frequently occurred. The research on nursery techniques made it clear that an optimal sowing depth (1 cm), closing the furrow with soil or a mixture of soil and stable manure and frequently and carefully watering are important factors in reaching a high seed efficiency. The plant density experiment showed a clear difference between TSS-varieties in reaction on plant density. There was also a difference between TSS-varieties in reaction on nitrogen fertilization. Also in these experiments, TSS was giving a higher yield than seed bulb crops.

In 2010 all activities were focused on dissemination of research results. Participatory demo fields were established on farms at six locations: two in Brebes, three in Nganjuk and one in Yogyakarta. In the demo fields the most interesting treatments were included: nursery techniques, TSS varieties grown at different plant densities and nitrogen fertilization levels, all with local seed bulb varieties as a reference. On three demo fields field days were organized. Three demo fields were lost, because of heavy rainfall and too wet growing conditions. Research results were presented and farmers and agronomist gave their opinion about the different techniques. Results were presented on posters and a printed guideline for growing TSS was distributed. Farmer’s scorings and data of the treatments were collected, including data about costs of production and yield obtained.

In total 68 farmers attended the field days. About 50% of the farmers did not have experience with TSS production. Especially in Nganjuk a number of farmers became interested in the production of Sanren. Farmers’ adoption of TSS was taken place as the impact of conducting the field days. In the beginning of November, it was recorded that the number of farmer’s adopters were 6 farmers in Brebes and 12 farmers in Nganjuk. A total of 19 kg seed of Sanren and 600 kg seed bulbs of Sanren F2 were bought by the adopters to try out.

Based on the research done in 2007 - 2010 a final report was made. In a leaflet recommendations were given about the most optimal way of TSS production.
Planting of shallots.

2.1.3.6. Conclusions
The project has shown that introduction of TSS is a realistic option to make shallot production in Indonesia more productive and competitive. Especially the new developed variety, Sanren, is giving good results. Compared to the older variety Tuktuk, Sanren is an improvement in yield, disease resistance, grading and earliness and besides Sanren is better accepted by the market.

The project has shown that nurseries on seedbeds in the field are a cost effective method of producing seedlings. Nurseries in trays can give a higher seed efficiency, but the inputs for such nurseries are high and very often locally not available. Seed efficiency in nurseries on a seed bed in the field could be improved by sowing at the optimal sowing depth of 1 cm and closing the furrows carefully with soil or mixtures of sandy soil and stable manure.

Survival after transplanting individual seedlings is good. Under normal weather conditions during dry season productivity of TSS is much higher than productivity of seed bulb crops, while costs of production are only slightly higher than production costs of seed bulb crops (ca 3 – 10%). In experiments of 2008 and 2009 the average yield of Tuktuk was 70% higher than Bima curut grown form seed bulbs bought from store. The yield of Sanren was 113% higher than Bima curut.

2.1.3.7. Recommendations
The following recommendations are made:
- Introduction of TSS in Indonesia should be promoted by the Extension Service and research organizations. This can be done by organizing demo fields and field days.
- The authorities could promote the use of TSS by facilitating farmers to get credit for buying seed or TSS seedlings.
- Farmers could specialize in producing TSS- seedlings in order to sell these seedlings to colleague farmers.
- A prerequisite is the availability of TSS-seed in large quantities to meet the demand by farmers.
- Breeding activities should be continued in order to get even better varieties which are well adapted to the Indonesian conditions, especially varieties which are performing well under rainy conditions.
- Additional research is needed to obtain a more reliable and profitable TSS production. Research should address control of pest and diseases, optimum fertilization and optimum plant density.
- Further research is needed to study the impact of wide spread TSS adoption on the increase of yield, cost reduction and profit improvement of farmers.
The project has shown that with the use of new techniques the yield will increase.

2.1.3.8. Training, technology transfer and knowledge exchange
On several occasions workshops with farmers, traders and the Extension service were organized: one in Brebes in 2007, one in Brebes in 2008, one in Brebes and one in Nganjuk in 2009. In these workshops TSS technology was presented and discussed. In 2008 a field day was organized to present results and to exchange information with farmers and extension agronomists. In 2010 demo fields were conducted on six locations: two in Brebes, three in Nganjuk and one in Yogyakarta. On three of these locations a field day was organized. On these field days results were presented and shown on posters. A leaflet with guidelines for TSS production was handed out to each visitor. A local TV-station has broadcasted the activities of the field day in Nganjuk on television.

2.1.3.9. Reports, publications
- Research Report 19. Improvement of shallot supply chains; Research Report 2010; Dissemination of shallot production technology of True Seed Shallot (TSS) through conducting farmers’ field days on participatory demplots.

- Gina Allya Sopha and R.S. Basuki. 2010. Pengaruh komposisi media semai lokal terhadap pertumbuhan


- Teknik Produksi Bawang Merah Menggunakan Biji Botani. Leaflet on production technique of True Seed Shallots. 4 pp.

2.1.3.10. Presentations

*Field days and workshops were organized to disseminate results to the stakeholders.*
2.1.4. Hot pepper co-innovation development based on supply chain analysis (HotPep)

2.1.4.1. Project leaders
- Witono Adiyoga, Indonesian Vegetable Research Institute, Lembang, Indonesia.

2.1.4.2. Executing agencies
- Indonesian Vegetable Research Institute, Lembang.
- Indonesian Center for Horticultural Research and Development, Jakarta.
- Wageningen UR, Applied Plant Research, Lelystad.

2.1.4.3. Participating organizations
- PT East West Seed Indonesia, Purwakarta.
- Syngenta, Jakarta.
- Farmers Group, Kersana, Brebes.

2.1.4.4. Aim of the project

Long-term objectives
- Developing a sustainable production system of hot pepper production in lowland areas.
- Increasing the yield of hot pepper in lowland areas.

Short-term objectives
- Identifying the priority bottlenecks in the hot pepper supply chain based on a participatory approach.
- Improving the seedling system (nursery) to increase the quality of hot pepper planting material.
- Increase the availability of hot pepper varieties that have high yield potential and other desired attributes, and are suitable for the farmers’ circumstances.

Purpose
- Introducing techniques to farmers based on on-farm research.
- Testing new techniques jointly with research institute, private companies and farmers.
- Assessing the impact on farmers’ income by conducting an economic evaluation on both existing and new techniques.

2.1.4.5. Activities, results and realization

The aims of the project were to develop and test transplant raising techniques in simple nursery constructions and to introduce hybrid varieties of hot pepper. Seed costs of hybrid varieties are higher than that of open pollinated varieties, resulting in low acceptance by the farmers even when hybrid varieties produce higher yields. By using transplants farmers can actually reduce the amount of seeds needed for cultivation. Consequently, the use of hybrid varieties becomes within reach of the farmers. The use of hybrid varieties and transplants may also reduce pesticide-use due to a better start of the cultivation and pest and disease resistance embedded in those varieties.

Both variety testing and transplant raising techniques were carried out under the local farmers’ conditions and targeted to making local hot pepper production more productive and competitive. Commonly hot pepper is cultivated as an intercrop with shallot. Shallot is considered the main crop by the farmers. In the period of 2007 till 2010, a total of 10 hot pepper experiments (intercropped with shallot) have been carried out to test and to demonstrate the effect of:
- Transplant raising methods;
- Use of a hybrid variety compared to an open pollinated variety;
- Different cultivation techniques (plastic mulch, planting depth, planting distance, mono-cropping, etc.);
- Cultivation in net houses.
**Shallot – Hot pepper intercropping**
Out of the 10 experiments, three showed reasonable good yield levels, five showed low yield levels and two experiments failed.
Based on collected data on yield, income, inputs and labor needed for the cultivation of shallot and hot pepper intercropping, shallot shows a share of about 80% in the total income, but in terms of inputs used the highest share of inputs is used in hot pepper. In some cases of hot pepper cultivation, the costs of used inputs, especially pesticides, even exceed the possible gross income.

**Effect of transplant raising**
In all experiments, a higher number of transplants from the nursery (seedling-raising) were present as compared to those from direct sowing. However, in terms of crop yield, the use of transplants (seedlings) did not show a better performance than direct sowing.
The costs of producing transplants from the nursery are higher than the costs of direct sowing, because of expenditures on nursery construction, materials to raise the seedlings and additional labor for transplanting. When using a hybrid variety, the savings on seeds will compensate the needed nursery investment. However, when farmers are using OP varieties with mostly farm-saved seeds that are cheap, the nursery investment does not pay off.

*Effect of variety*
The hybrid variety showed a higher production per plant than the open pollinated variety. However, since the hybrid variety was cultivated at a lower plant density, the yield per hectare between the two was quite similar.

*Effect of net house cultivation*
In order to optimize the growing conditions, cultivation of hot pepper in a net house construction was tested in three experiments. Compared to cultivation in the open field, the yield of hot pepper increased two to five-fold. This was due to not only better crop growth and plant development, but also because of reduced pest incidence. Marketable yields up to 25 tons per hectare have been observed in the net house, while the yield in the open field was only 2 to 7 tons per hectare.
Other than increasing the yield, the use of net houses was also able to reduce pesticide use. However, no positive effect of net houses was observed on shallot yields. Nonetheless, in all net house experiments, the presence of *Spodoptera* caterpillars as one of the most important yield reducing pests in shallot was low. It is
expected that cultivation in net houses may not only be minimizing the shallot yield loss because of *Spodoptera*, but will also reduce the use of pesticides.

*Hot pepper production and quality improves with cultivation in a net house.*

**Effect of cultivation techniques**
Amendment of fertilizer and insecticides to the transplants before transplanting did not give any improvements in yield. Mono-cropping of shallot and hot pepper did not improve the yields of both crops as compared to intercropping. In some cases, the yield of hot pepper even showed a decline. A slightly higher yield was obtained with the use of plastic mulch in combination with rice straw that was spread underneath the plastic mulch. However, use of plastic mulch alone resulted in yield decline, which was probably related to increased soil temperature and too high moisture content causing low oxygen levels in the rooting zone. Different planting depths did not show any effect on yield.

**2.1.4.6. Conclusions**
Climatic and soil conditions are still considered as the more decisive and important factors in determining crop success or failure rather than other factors, such as variety, starting planting material and fertilizer use. Only if those decisive conditions are favorable, positive effects of transplant use and variety on yield can be observed. Currently, the use of pesticides and fertilizers, in both shallot and hot pepper cultivation, is still considered excessive. In some cases, the costs spent for these two inputs have even exceeded the potential gross income. Moreover, farmers tend to spend more money on inputs needed for hot pepper cultivation, despite the fact that this crop has a relatively lower share than shallot in the total gross income of the intercropping. The use of transplant raising techniques has resulted in a higher number of transplants per used seeds. Hence, these techniques may reduce seed losses or increase seed-use efficiency. Only if the cultivation conditions are favorable, it is worthwhile to invest in hybrid varieties. Otherwise, the use of hybrid varieties is too risky since the chance of crop failure is quite high. The potential yield of OP varieties is lower than that of the hybrid varieties. However, the potential yield of the latter is frequently unreachable because of unfavorable climatic and soil conditions. Furthermore, the impact on yield of losing one hybrid plant is two times higher than losing one OP plant, since the hybrid variety has a lower plant density and higher yield per plant. Net house cultivation shows a significant positive impact on hot pepper yield and on pesticide-use reduction.

**2.1.4.7. Recommendations**
In order to increase the yield of hot pepper, it is recommended to stimulate the cultivation in net houses, including the use of transplants and other new cultivation techniques, while more attention should be given to the improvements of soil structure.
Considering the costs of cultivation in net houses are much higher than open field cultivation, farmers' access to credit facilities should be further developed. Simultaneously, farmers should also be well-trained in net house cultivation, gradually convincing them of the benefits of reducing fertilizer and pesticide-use.

2.1.4.8. Training, technology transfer and knowledge exchange

During the project period, several meetings, workshops and informal visits were organized. A farmers group of 6-10 farmers was invited regularly to the field to observe, evaluate and discuss the experiments. Based on these regular field visits and interactive discussions, further improved treatments were designed for the next experiments.

Each year a one day workshop was organized for farmers in the region and other stakeholders, such as representatives of agribusiness and extension service to:

- Disseminate the research results;
- Discuss the practical application of research results and its implementation at farmer's level;
- Discuss new research ideas with the stakeholders.

During the workshops, presentations on research results, as well as visits to the experimental fields were organized. During the field visits, all visitors were asked to observe and evaluate the experiment and state their preference (on 1-10 scale-base) on some variables, such as crop appearance, estimated yield/production, implementation practicability on their own farm and estimated profitability. Based on the outcomes and discussions of those surveys, the next research plans were established.

In 2010, trainings on hot pepper transplant raising techniques and net house cultivation were organized. During cultivation five visits, once a month, were organized for local farmers. At these visits farmers were informed about the progress and they were shown how seedlings were raised.

On August 18 a workshop was organized at which about 100 farmers, extension service officers and other stakeholders were present. Topics that were demonstrated were techniques to raise seedlings (tray choice, media preparation, sowing), use of hybrid varieties, cultivation techniques (mulching, planting distance, and net house) and crop protection.

Regular meetings with farmers were essential for the co-innovation process.

2.1.4.9. Reports, publications

• Research Report 7. Influence of raising system, tray use and variety on seedling raising and yield of hot pepper.
• Research Report 8. Influence of nursery, Actara drench and variety on transplant raising and yield of hot pepper.
• Research Report 10. Effect of variety, container type, Regent drench, transplant depth and transplant age on transplant raising and yield of hot pepper.
• Research Report 11. Effect of sowing technique, nursery and variety on transplant raising and yield of hot pepper.
• Research Report 15. Effect of variety, screen net, mulch and cropping system on hot pepper growth and yield.
• Research Report 25. Effect of variety, transplant raising, net house cultivation, mulch and cropping system on hot pepper growth and yield.
• Research Report 26. Report on dissemination activities during the hot pepper research.

2.1.4.10. Presentations
• Hot pepper research IVEGRI-APR. HORTIN-II meeting. Wageningen, 8 November 2007.
• Hot pepper research IVEGRI – APR. HORTIN-II Meeting with IVEGRI researchers and EWINDO representatives. Lembang, December 11, 2007.
• Hot pepper research IVEGRI-APR. HORTIN-II meeting. Wageningen, June 3, 2008.
• Pengenalan organisme penggangu tumbuhan (OPT) tanaman cabai dan pengendaliannya berdasarkan konsepti PHT(Hotpepper pest and disease idenfication and control). Workshop Hot pepper. Kersana, August 27, 2008.
• Hot pepper research IVEGRI – APR. HORTIN-II Meeting with IVEGRI researchers and EWINDO representatives. Lembang, December 3, 2008.
• Hot pep: results and plans. HORTIN-II meeting. Wageningen, January 26, 2010.
New cultivation techniques and hybrid varieties improve the yield of hot pepper.
2.1.5. Quantitative Economic Analysis (QEA)

2.1.5.1. Project leaders

- Witono Adiyoga, Indonesian Vegetable Research Institute, Lembang, Indonesia.

2.1.5.2. Executing agencies

- Indonesian Vegetable Research Institute, Lembang.
- Wageningen UR, Applied Plant Research, Lelystad.

2.1.5.3. Participating organizations

N.a.

2.1.5.4. Aim of the project

The Quantitative Economic Analysis (QEA) project was supplementary to the three crop based projects within the HORTIN-II programme. The QEA project used the data from each of the three crop based projects to determine the economic impact of the innovations made in the cultivation practices. This all in relation to the current cultivation practices for the three crops in Indonesia.

2.1.5.5. Activities, results and realization

**Activities**

The project consisted of four parts:

- Data collection at farm level for each of the three crops. The data gave insight in the economics (gross margin/cost price) of the three crops in current cultivation practices.
- Economic calculations for each of the three crop based, technical projects. The calculations gave insight in the economic effect of the innovations. A selection was made of the most promising innovations.
- The calculation of the effects of the most promising innovations on farmer’s practices. This together with the economic calculations of the three crop based projects.
- Dissemination of results and knowledge transfer. The knowledge transfer part of the QEA project consisted in the first place of knowledge transfer to farmers and extension workers. This should improve the farmer’s insight in the gross margin and cost price effects of the innovation techniques. Secondly, knowledge transfer to the Indonesian researchers took place. The knowledge transfer and training should raise the economic awareness of Indonesian farmers and researchers.

**Realization**

2007
- Project start up and formulation of approach.
- Evaluation of preliminary findings on the economics of current cultivation techniques for hot pepper, shallots and sweet pepper.

2008
- Data collection and calculation on the economics of the crop based innovation projects.
- Develop a model for economic calculations for Indonesian researchers.

2009
- Report and communication activities on economics of improved cultivation techniques for hot pepper, shallots and sweet pepper.
- Farmers and other participants were trained in cost price and profitability calculations in workshops of the other projects.

2010
- Final report and communication activities on economics of improved cultivation techniques for hot pepper, shallots and sweet pepper.
- Workshops on economics of improved cultivation techniques for hot pepper, shallots and sweet pepper in the other projects meetings, where farmers and other participants were trained in cost price and profitability.
Finalization of three models (in Excel), including a user guide and description, as part of the knowledge transfer. The models are available on request with the Indonesian and the Dutch researchers.

Results

Sweet pepper
- Two, three and four stems per plant.
  The three stems per plant system lead to the highest gross margin per m². The effect varies per variety, but the yield increase ranges between 1.5 and 2 kg per m².
- Varieties.
  The researched varieties were Spider, E41.9560, Zamboni and Inspiration. Spider gives the highest gross margin / yield per m². The yield is about 0.4 kg per m² higher as the second best performing variety (Zamboni) and is about 1.5 kg per m² more as the poorest performing variety (E41.9560).

Shallots
- Seedlings use versus direct sowing.
  The use of seedlings instead of direct sowing is more economically viable. Also the use of seedlings is more economically viable than seed bulbs. The main effect is a significantly higher shallot yield. If sown directly the imported variety Ilokos gives the best gross margin.
- Hybrid varieties perform better.
  The hybrid variety Sanren performs better than local OP variety Tuktuk.
- Fertilizer.
  The effect of increasing levels of N-fertilizer application show different results per variety. The Tuktuk variety has the best gross margin with a 180 kg N-fertilizer application per hectare. The hybrid Sanren has the best gross margin at 300 kg N-fertilizer application per hectare. The Sanren variety could maybe benefit from an even higher N-fertilizer application. This was not part of the experiment. The increase in yield shows no relapse per step N-fertilizer increase.
- High plant density (175 seedlings per m²).
  The optimum plant density is 175 seedlings per m². This plant/seedling density shows a good yield level in comparison to the costs of seedlings. There is a difference between Tuktuk and Sanren in reaction to plant density. The response of Sanren on lower plant densities fluctuates less erratic. The response of Tuktuk on
lower plant densities fluctuates considerably.

**Hot Pepper**

- **Seedlings versus direct sowing.**
The use of seedlings instead of direct sowing is not economically viable. The main effect is a slightly higher yield in hot pepper (intercropped with shallot). The yield effect of seedling use is too low to compensate the costs of seedlings. In both cases the gross margin is negative (between -1.5 and -1.8 million IDR per bagian).

- **Open field versus Screen Net.**
The use of a screen net in field production of hot pepper has a tremendous positive effect on the yield of hot pepper. The yield is about 2.5 times higher compared to the current cultivation practice. Due to the tremendous effect on the yield of hot pepper the costs of the screen net results in a positive gross margin. The gross margin is between 7 and 8.6 million IDR per bagian (OP versus hybrid seedlings).
  - **Open field versus Screen net.**
    - The use of seedlings leads to a positive effect when the screen net is used. The gross margin increases with 1.6 million IDR per bagian when seedlings are used under the screen net.

**Economic results**

- The effect on the gross margin of all technical improvements in cultivation was calculated. This effect showed the following results per crop. The results are based on the farmer reference combined with the research results.
  - **Hot pepper/shallot**
    - Hot pepper and shallot are intercropped in Indonesia. Due to this fact there are three results, per crop and combined. All technical improvements in hot pepper lead to a 2.8 time increase in gross margin. All technical improvements in shallot lead to a 1.4 time increase in gross margin. The combined results are a 2.9 time increase in gross margin for hot pepper and shallot.
  - **Sweet pepper**
    - The combined result of the sweet pepper research shows a potential range of 1.2 till 1.8 time increase in net farm income. The effect on the farm income is rather specific per farm/greenhouse management, hence the range.

- In all cases the effects of increase in yield and of reduction in costs (or equal costs) have a significant financial effect.
- All economic results are the theoretical maximum increase possible. Further testing of results in practice is recommended.

**2.1.5.6. Conclusions**

Based on the experience of the QEA project a number of conclusions were drawn:

- **Poor economic insight by farmers.**
The Indonesian farmers do not keep written records of yields and used inputs. The poor insight in yield and inputs shows that the reference data given do not represent the actual situation. The yield usually is estimated too high and the costs are commonly estimated too low. The prices of the produce and inputs are also estimates. The economic data provided by the farmers are therefore considered not reliable. The economic data provided by the farmers only give a general picture of the cultivation practice of the crops in Indonesia.

- **No clear basis in economic calculations.**
The economic calculations started with the development of a useable method of economic calculation. The economic data must be interpreted correctly, in order to come to good conclusions. There are differences in method and basic premises in the methods used in the past. The consequence of different methods of gross margin calculations is that the results of the past and the present are not comparable.

- **High pesticide use.**
  - A previous project, HORTIN-GAP, confirmed the high use of pesticides in Indonesian vegetable cultivation.
Main reasons were the use of the calendar system for spraying and limited knowledge of farmers on rules and regulations. Intercropping caused the use of not-permitted pesticides on secondary crops. Control of the pesticide application rules by the government is poor. In the present project high pesticide use resurfaced. There is a significant negative economic impact of the high amounts of pesticide used. This could be an economic stimulus for change in pesticide application behavior by farmers.

2.1.5.7. Recommendations

Based on the experience of the QEA project a number of recommendations can be made:

- **Increase economic knowledge.**
  The most basic level of record keeping is lacking at farm level. The lack of reliable records at farm level prevents research and policy making from drawing conclusions and impact assessments. A side effect is a low level of economic awareness of farmers. All parties involved should aim for increasing the economic knowledge. Indonesian farmers are driven by economic stimulus. Increasing economic knowledge can therefore be used as driver to stimulate the required change in cultivation techniques.

- **Start with an economic evaluation.**
  The potential technical cultivation innovations were basic premises of the project. When the economics of the crop production are known, the economic effect of potential innovations can be calculated in advance. The benefit of this approach is that technical research is more cost efficient. Technical research has high costs. Insight in promising cultivation techniques in advance, provides focus on economic viable cultivation techniques. This helps to save expensive research time and effort.

- **Measurable data.**
  The collected economic data of farmers were based on the recollection of the farmer. This proved to be an inaccurate representation of the reality. The economic results of this project could therefore be only poorly projected on the economic data of the farmers. The collection of economic data on crop cultivation of major vegetable crops in Indonesia is therefore recommended.

- **Use the economic consequence of excessive pesticide use in policy making.**
  The high pesticide use results in high costs for farmers. The high costs of pesticides proved to be a stimulus to change current cultivation practice. The government can therefore use this to their advantage. They can highlight the alternative techniques to farmers with an economic explanation. In this way the government is positively stimulating desired behavior of farmers. The economic stimulus can be incorporated into policy making.

- **Hot pepper.**
  The screen net, in combination with hybrid seedlings, has the best gross margin. The screen net costs are substantial (7.9 million IDR per bagian). It could be researched if there are more crops that benefit in a similar way to use of the screen net like hot pepper. The screen net could then also be for multiple crops. This could reduce the costs per bagian
  The hot pepper could be mono-cropped under the screen net. The plant density of hot pepper can then probably be raise to further increase the yield per bagian. The shallot did not benefit from the screen net. Further optimization is therefore seen in the option of mono-cropping.

- **Shallots.**
  The use of hybrid seedlings shows a significant yield increase. Based on the average yield of the interviewed farmers a 3.5 time's higher yield can be obtained.
  The use of fertilizer to increase yield is an interesting option. The fertilizer costs make up a small part of the total variable costs. Therefore a relatively small increase in costs gives a substantial yield increase. The optimization of fertilizer application is therefore recommended. This varies per variety, but for Sanren the tipping point was not found in the present experiment.

- **Sweet Pepper.**
  The cultivation of sweet pepper can start at any time. This is due to the climate situation in Indonesia. This means that the grower can vary the cultivation period. The price variation throughout the year can be a basis for the planning of the cultivation. The required price information was not available in this project. The option of variation of cultivation period based on price information should be investigated.
  More options in improving not only cultivation techniques, but also improve greenhouse and related systems and materials could provide further economic improvement options. The step from bamboo to wood-metal type greenhouses is a first step. Another option is the 11.2 stems per m² option. Further improvements in irrigation and media could be implemented in practice.
2.1.5.8. Training, technology transfer and knowledge exchange
Knowledge transfer in the Quantitative Economic Analysis project was made up of two parts. The first part was the transfer of knowledge to Indonesian farmers and extension workers. The second part involved knowledge transfer to Indonesian researchers.

The knowledge transfer to Indonesian farmers and extension workers was based on two goals. The first goal was to exchange knowledge on making basic economic farm calculations. The second goal was to exchange knowledge on economic results of the innovations in cultivation.

The knowledge transfer to farmers was integrated into the knowledge transfer activities of the technical projects in 2010. Within each of the technical projects field demonstrations, lectures and poster presentations were held.

For the Indonesian researchers knowledge transfer was incorporated in the co-operation project. Especially the methods and approaches of economic calculations were transferred while working together. For example the explanation of why data are required and how the economic results are calculated, helped to achieve a better insight in making economic farm calculations. Special emphasis was put on economics to support technical research.

For each of the crops an excel-model has been developed to support economic calculations of technical research. The models are available for future projects.

2.1.5.9. Reports, publications
Product quality is also important after harvesting and packing.
2.1.6. Supply chain development (SCD)

2.1.6.1. Project leaders
- Rofik Sinung Basuki, Nikardi Gunadi, Witono Adiyoga, Indonesian Vegetable Research Institute, Lembang, Indonesia.
- Rara Dewianti, Iskandar Zulkarnain, Horti Chain Centre, Jakarta, Indonesia.

2.1.6.2. Executing agencies
- Indonesian Vegetable Research Institute, Lembang, Indonesia.
- Horti Chain Centre, Jakarta, Indonesia.

2.1.6.3. Participating organizations
- Directorate General of Agricultural Product Marketing and Post Harvest, Jakarta.
- Farmer group Mitra Suka Maju, Pasirlangu, Lembang.
- Retail Companies, Hero, MataHari, Makro Cash and Carry, Ranch Market and KemFarm, Jakarta.
- East West Seed Indonesia, Purwakarta.
- Individual sweet pepper producers, Cisarua.

Co-operation of farmers in the supply chain is important to deal directly with retailers.

2.1.6.4. Aim of the project
- To enable all chain actors and policy makers to examine the farm and industry level value chain, to identify, establish and understand the relationships of key players along the chain, as well as to identify gaps and opportunities for development and interventions or market-based solutions, fine-tuned to the market needs.
- Analysis of the shallot, sweet and hot pepper chains to be used as a starting point for determining appropriate developmental interventions and allowing a seamless integration of technical and supply chain programs, thus resulting in the optimal utilization of resources.

2.1.6.5. Activities, results and realization
Based on the pilot supply chain development project the following three main research and development themes were carried out:
- Improvement of productivity and sustainability of sweet pepper production systems that meet export market demand.
- Improvement of the efficiency of sweet pepper export market chains through targeted innovations in markets and institutions.
- Development of approaches for human resources development and entrepreneurship within the sweet
pepper sub-sectors.

**Sweet and hot pepper**

The following main activities were conducted during the preparatory phase in 2007 and 2008:

- Potential linkages between producer groups of sweet and hot pepper and high value (modern retail) market segments were identified and business opportunities and constraints explored.
- Synergy and linkages between these potential supply chains activities in the ongoing technical HORTIN-II crop based research programme were explored.
- The first two activities were supported through targeted training, registration, business planning, match making activities, surveys and other relevant activities through the local supply chain facilitator, backstopped by project partners.
- Documentation of experiences, including opportunities and constraints for linking small scale producers with high value market segments by means of technical innovations and supply chain facilitators.

During the implementation of this project in 2009 and 2010 the following activities were conducted:

- In April, 2009 workshops and surveys were conducted in order to identify and assess problems and needs in sweet pepper supply chains.
- The full preparation of the set-up and carrying out of a sweet pepper cultivation in a wood-metal plastic house was supervised by the team to strengthen the sweet pepper supply chain.
- A base line survey of hot pepper supply chains (SC) was conducted in Brebes Area (Central Java) among producers, traders and input suppliers. Constraints and development opportunities with regard to production, post harvest practices, logistics, marketing and pricing were identified in collaboration with SC actors.

**Impact assessment**

Furthermore in 2010 a workshop was conducted with stakeholders of the sweet supply chain to prepare for an actual evaluation and impact assessment of the sweet pepper activities. The workshop had a twofold objective:

- To provide practical guidelines in setting up a framework for project impact assessment;
- To work out the impact assessment framework of the HORTIN-II sweet pepper project as a case example.

**Export**

In 2009 a desk study and a concise market analyses was conducted on regional trade flows of vegetables. Import and export volume and values of fresh fruits and vegetables were mapped and analyzed. In 2010 a more detailed study was conducted on export opportunities of Indonesian vegetables to Singapore and Malaysia. The focus was on fresh vegetables with a particular interest in, but not limited to, sweet pepper and shallots.

**Training on standards**

In 2009 trainings sessions were organized for the members of the sweet pepper growers’ group, staff of the Indonesian Vegetable Research Institute and Ministry of Agriculture (Directorate General Horticulture) staff on the following topics:

- Standard Operational Procedures and Food Safety;
- Introduction on GlobalGAP certification system;
- How to develop a monitoring and administration system for sweet pepper and other crops;
- Monitoring methodologies.

**Results**

**Sweet and hot pepper**

The following results are reported:

- The results of the survey on retail market developments in Indonesia revealed that there is a fast emerging retail market segment offering opportunities for small vegetables producers.
- The HORTIN-II SC facilitator has organized meetings between retailer’s representatives and farmers. Retailers have expressed their demands in terms of volumes, quality standards and product attributes such as packaging and labels.
- The sweet pepper grower group has started the actual delivery of sweet peppers to RanchMarket and MataHari.
• A training course for management and members of the growers’ group was conducted in August 2008.

• For hot pepper the HORTIN-II team was not able to identify a producers’ association involved in and committed to the marketing of their produce. This is more or less inherent to the product because hot pepper is traded as a commodity rather than a specialty product with added value. However, it was expressed by retailers that they are interested in pesticide low (or free) hot pepper at an affordable price, which might generate more traffic (customers) in their outlets.

• A discussion and field day with hot pepper growers, East West Seed Indonesia staff, retailer representatives and traders on hot pepper varieties and cultivation practices was conducted in September 2009.

Impact assessment
From the evaluation and impact assessment of the sweet pepper activities it was learned that production of sweet pepper in a modern wood-metal plastic house, using improved varieties and advanced production techniques in a supply chain context, results in higher production per m², lower input and production costs per kilogram and enhanced marketing opportunities.

Export
The studies on export opportunities concluded the possibilities for regional export are very limited given the specific supply chain constraints in Indonesia. Indonesia was already a net importer of fruits and vegetables before 2010, when AFTA became effective. It is recommended that rather than explore export opportunities, which is feasible for some vegetable products only, the Indonesian horticultural sector should focus on import substitution. There is a serious risk that the Indonesian market will be flooded with high quality, uniform and cheap fruits and vegetables from neighboring countries and China.

Training on standards
Results have been achieved and also the dialogue on strengthening the national system for food safety including the benchmarking process of IndoGap with GlobalGAP has been geared up.

To be able to supply to supermarkets farmers need to be trained in product standards.

2.1.6.6. Conclusions
Sweet pepper producers were the direct beneficiaries of the activities. Capacity building with growers, researchers, DG HORT staff and local consultants also has to be taken into account and considerable inputs
have been spent on training and workshops. Opportunities for regional export are very limited given the specific supply chain constraints in Indonesia. In the Indonesian horticultural sector Indonesia there is an urgent need for a harmonized approach for national and international food safety assurance and certification.

2.1.6.7. Recommendations
Investments in a modern wood-metal plastic house, provided that the farmer has access to capital, lead to a higher profit margin and a good Return on Investment. At the present stage, the Indonesian horticultural sector should focus on import substitution, rather than looking for export opportunities. The benchmarking of the national IndoGAP standard with the international GlobalGAP standard is an essential step for advanced supply chain development.

2.1.6.8. Training, technology transfer and knowledge exchange
Training sessions, workshops and hands on learning by doing training were conducted during the whole project period.

2.1.6.9. Reports, publications
- Research Report 22. Export market study for sweet pepper and shallots from Indonesia.

2.1.6.10. Presentations
- Co-innovation and added value in the sweet pepper chain. Lembang, April 17, 2009.
2.1.7. Product diversification and quality improvement of rambutan (Fruits).

2.1.7.1. Project leaders
- Jeroen Knol, Wageningen UR, Food & Biobased Research, Wageningen, the Netherlands.
- Sri Yuliani, Indonesian Centre for Agricultural Post Harvest Research and Development, Bogor, Indonesia.

2.1.7.2. Executing agencies
- Wageningen UR, Food & Biobased Research, Wageningen.
- Indonesian Centre for Agricultural Post Harvest Research and Development, Bogor.

2.1.7.3. Participating organizations
- Study Centre of Tropical Fruit, Institut Pertanian, Bogor, Indonesia.
- Indonesian Tropical Fruit Research Institute, Solok, Indonesia.
- Horti Chain Centre, Jakarta, Indonesia.
- Fresh Studio Innovations Asia, Huissen, The Netherlands.
- C.V.. Sumber Buah, Cirebon, Indonesia.
- P.T. Matahari Pruta Prima, Jakarta, Indonesia.

2.1.7.4. Aim of the project
To contribute to the development of the fruit sector in Indonesia and generate employment and income for rambutan producers by optimizing the supply chain for fruit products.

2.1.7.5. Activities, results and realization
In 2008 the first activities were aimed at investigating, via literature reviews and interviews with stakeholders, the options for processing, packaging and harvest extension of rambutan. Based on the outcomes of these activities, the following activities were carried out in 2009 – 2010:
- Experiments with processing techniques;
- Experiments with modified atmosphere packaging (MAP);
- Study of the Thai supply chain;
- Export and supermarket trial;
- Dissemination workshop.

The main activities focused on processing, packaging and harvest extension. Below, a brief description of the main results is given. Detailed information can be found in the Mission and Research reports.

Processing possibilities for rambutan
A whole range of processing technologies can be applied to extend the shelf life and quality of rambutan. All technologies reported have been evaluated based on their effect on quality, appearance and costs. Table 1 shows an overview of all technologies and their effect. Not all technologies are feasible to implement on the Indonesian market, due to regulations and high investments for novel processing. Since there is a lot of variety in ripeness between the harvested rambutan within each bunch, it is advised to classify the rambutans in three categories; unripe, ripe and overripe rambutan. Each of these categories can be treated with an own processing technology, which gives the easiest handling and best quality products.

Unripe rambutan (harvested approximately 15 days too early) can be used for canning, overripe rambutan can be used for fermentation or processing with sugar / yel1ing due to its flavor and high sugar content, and ripe rambutan can be used for all other processes. As juice processing and preservation (canning) are the most promising technologies, they have been further studied within the HORTIN-II project. Experiments have shown that the shelf life of rambutan can be greatly extended by these relatively cheap and proven processes, making them ideal for implementation in Indonesia. Processed rambutan can be stored at ambient temperatures (30˚C) for 2 months. Rambutan juice can have a storage life up to 4 months.

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Table 1. Overview of processing methods and their effect on quality, appearance and costs.

<table>
<thead>
<tr>
<th>Processing</th>
<th>pasteurization</th>
<th>sterilization</th>
<th>vegetative cells</th>
<th>enzymes inactivated</th>
<th>micro organisms inactivated</th>
<th>modified environment</th>
<th>shelf life extension</th>
<th>product properties affected</th>
<th>costs</th>
<th>suitable for rambutan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curing</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>weeks</td>
<td>yes</td>
<td>€</td>
<td>no</td>
</tr>
<tr>
<td>Drying</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>months</td>
<td>yes</td>
<td>€</td>
<td>yes</td>
</tr>
<tr>
<td>Canning</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>months</td>
<td>yes</td>
<td>€</td>
<td>yes</td>
</tr>
<tr>
<td>Addition of chemical additives</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>months</td>
<td>no; possibly €€</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Chilling</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>days</td>
<td>no; €€ €€ €€; Yes &gt; 5°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freezing</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>weeks</td>
<td>yes</td>
<td>€</td>
<td>no</td>
</tr>
<tr>
<td>Controlled atmosphere packaging</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>weeks</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Modified atmosphere packaging</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>weeks</td>
<td>no</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Aseptic packaging</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>months</td>
<td>yes</td>
<td>€€ €€ €€</td>
<td>yes</td>
</tr>
<tr>
<td>Irradiation</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>weeks</td>
<td>yes; depending on local regulations probably/yes</td>
<td>€€ €€ €€</td>
<td>yes</td>
</tr>
<tr>
<td>Fermentation</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>months</td>
<td>yes</td>
<td>€</td>
<td>yes</td>
</tr>
<tr>
<td>Pasteurization</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>weeks</td>
<td>yes</td>
<td>€</td>
<td>yes</td>
</tr>
<tr>
<td>Preservation with sugar</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>weeks</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Jellying</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>weeks</td>
<td>yes</td>
<td>€</td>
<td>yes</td>
</tr>
<tr>
<td>Wax / coating</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>days-weeks</td>
<td>no; too expensive</td>
<td>€€ €€</td>
<td>yes</td>
</tr>
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<td>High pressure processing</td>
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<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>weeks-months</td>
<td>yes</td>
<td>€€ €€ €€</td>
<td></td>
</tr>
<tr>
<td>Hot water treatment</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>days-weeks</td>
<td>yes</td>
<td>€</td>
<td>yes</td>
</tr>
<tr>
<td>Processing using ultrasound</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>weeks</td>
<td>yes</td>
<td>€€ €€</td>
<td></td>
</tr>
<tr>
<td>Vacuum frying</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>months</td>
<td>yes</td>
<td>€</td>
<td>yes</td>
</tr>
</tbody>
</table>

1) spoilage bacteria

Packaging possibilities for rambutan
It has been established that several packages and concepts permit to extend significantly the shelf life of fresh rambutan fruits. The majority of them are actually or already on the market, or easily applicable. However it is important to check the feasibility of implementing these concepts to the specific Indonesian rambutan production.

Equilibrium-Modified Atmosphere Packaging (EMAP)
Experiments conducted by the Indonesian Centre for Agricultural Post Harvest Research and Development and Wageningen UR, Food & Biobased Research have shown that by choosing optimal packaging and controlling the cold chain, shelf life of 18 days (varieties Binjai and Lebak Bulus) or 14 days (variety Rapia) can be achieved.

The packaging materials should answer to the following requirements:
• Relative humidity inside the bag around 95%;
• Condensation controlled by anti-fog material or water free absorber;
• Permeability properties of packaging material should avoid any anaerobic condition and assure a carbon
dioxide concentration between 9 and 12%;
• As packaging facilities at the exporter location are non-existing or extremely limited, the MAP packaging shouldn’t require high-tech equipment. The optimum gas concentrations should be reached by the natural respiration rate of the rambutan fruits.

Good handling of the products is necessary to assure the optimal initial quality and the maximum shelf life of rambutan. Gentle handling during harvest and transport minimizes mechanical damages and avoids any enzymatic decays of fruits. However, taking into account the high range of temperature occurring during the exportation of the fruits, it is recommended to postpone the packing process to the arrival of the rambutan in Europe.

Improving the temperature of the product during the exportation by using cooling box (with aeration holes) and reducing the transit period between the different planes can help to maintain the quality of the fruits.

**Controlled atmosphere**
Knowing that rambutan is a non-climacteric fruit, it is not possible to harvest unripe fruit, transport them to Europe under Controlled Atmosphere (CA) and apply an ethylene shock treatment to induce the ripening process. Transport under CA conditions is only possible by using mature rambutan. The present screening showed that long transport under CA is not possible for rambutan. Indeed after 4 weeks of storage under several control atmosphere conditions, the quality of the rambutan was not maintained well enough to assure any commercialization of the product. Fungi development is one of the main problems met at the opening of the containers. Additionally to this sanitary problem, brown coloration and off-taste development has been observed for the non-optimized atmosphere. CA transport can be probably envisaged for shorter distance. By applying a good sanitary control of the rambutan and limiting the storage period to 2 weeks, the quality attributes of the rambutan should be still acceptable for commercialization upon arrival.

**Additional remarks**
• For exportation purpose, standardization of the rambutan quality is needed. Special attention should be given to the control of the ripening stage, the color, the form and the taste of the rambutan.
• Sorting and cleaning are essential to facilitate the exportation of this fruit. In order to avoid fungi development during the CA transport, an appropriate cleaning protocol should be applied and fungicide may be needed.

*Rambutan supply is high and prices are low due to a short season.*
Opportunities for (pre-)harvest handling
A study of the Thai rambutan sector has shown that there are opportunities for the Indonesian farmers to improve the quality of rambutan at farm level. Improving cultural practices in pre-harvest and harvest handling can contribute to a better quality of rambutan fruits. This will influence the price and prolong the shelf life. Table 2 shows the differences in cultural practices of Thai and Indonesian farmers.

<table>
<thead>
<tr>
<th>Cultural practice</th>
<th>Thailand</th>
<th>Indonesia</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Thinning bunch</td>
<td>Thinning of bunch: keep 8-10 fruits per bunch</td>
<td>A bunch of rambutan on a tree without pruning</td>
<td>Benefit for fruit: Reduce sugar competition in fruits, reduce fungi growth (due to lower density of fruits per bunch) and decrease ant habitat.</td>
</tr>
<tr>
<td>2. Sorting and grading</td>
<td>Sorting and grading at farm: Sorting of bunch and grading of single fruit</td>
<td>Selecting abortive fruits out of bunch</td>
<td>Sorting of grade A (single fruit), bunch and off grade.</td>
</tr>
<tr>
<td>3. Transportation</td>
<td>Transport of rambutan in boxes or baskets</td>
<td>Transport of rambutan</td>
<td>Transport of packed rambutan (in boxes or baskets) is easier for transportation, saves time to transfer from one truck to another and decrease physical damage.</td>
</tr>
</tbody>
</table>

2.1.7.6. Conclusions
Rambutan is a highly seasonal product, which prices drop sharply during the peak production and harvest season in Indonesia. Processing and packaging of rambutan can improve the profitability for growers. Canning and juice making seem to be the most feasible processing options for rambutan at the moment. The application of modified atmosphere packaging (MAP) and cold storage could improve the shelf life almost to 3 weeks. Obviously sea transport of rambutan is not an option, because none of the treatments (CA or MAP) results in longer shelf life than 14 – 18 days (depending on the variety). The so-called sea-air bridge is also no option because the distance from Jakarta to Dubai by sea transport is too large. The options of extending the harvest season seem to be limited, but optimizations can be made in (pre-)harvest handling to improve the overall quality of rambutan.

2.1.7.7. Recommendations
Instead of focusing only on the optimization of MAP plastic films, the focus should be simultaneously on cold chain management. Once Indonesian traders and exporters control the conditions during transport, this could be combined with the best MAP options. This should be done by trying to export / trade Indonesian rambutan by the “Thai way” by doing a cold chain audit. One can than decide whether to use pre-cooling facilities close to the farms; whether to use foam boxes and dry ice or gel packs; whether to use insulating blankets; cooling facilities at the airport etc and combine these measures with the application of MAP films. The Thai are quite successful in keeping their products (such as asparagus, baby corn and fruits) cool all the way to the UK or Australia.

2.1.7.8. Training, technology transfer and knowledge exchange
The workshop that was held in April 2010 has been successfully attended by more than 100 participants representing relevant stakeholders in rambutan marketing: government, research institutes, university, farmer, business association, chamber of commerce, retail, fruit and vegetable exporter, logistics provider, media, and packaging manufacturer.

The objectives of this workshop were:

- To explore the potency and opportunity of rambutan in domestic and export markets;
- To disseminate processing and handling technology of rambutan as result of the research from ICAPRD in cooperation with Wageningen UR, The Netherlands;
- To initiate partnerships and cooperation in agribusiness;
- To gain feedback from this cooperation in research and development.

There was much interest in the possibilities of processing and MAP packaging of rambutan. Especially regarding MAP, parties were eager to have the MAP film available in Indonesia for export/trading activities.

2.1.7.9. Reports, publications


2.1.7.10. Presentations
Transport and handling has a big impact on shelf life and product quality of rambutan.
2.2. Policy workshop

2.2.1. Introduction
On November 9, 2009, at the Head Office of the Indonesian Center for Horticultural Research and Development (ICHORD), Jakarta, a workshop was organized for Indonesian policy makers. At the workshop lessons learned from the HORTIN-II programme on how to successfully stimulate horticultural development were presented to representatives of the Directorate Horticulture of the Ministry of Agriculture and of the Indonesian Agency for Agricultural Research and Development of the same Ministry.
At the workshop introductions to the HORTIN-II programme were given by Dr. Yusdar Hilman, Director ICHORD, by Mr. Hans van der Zijden, Agricultural Counselor, Royal Netherlands Embassy, Jakarta and Dr. Haryono, Secretary of the Indonesian Agency for Agricultural Research and Development. Results of the programme were presented at a poster session, where the respective researchers were present to give explanation. After the poster session, lessons learned were formulated. The workshop was attended by 52 persons, from the policy and research communities.

2.2.2. Conclusion
The lessons learned from implementation of the co-innovation approach in the HORTIN-II programme and the results of the discussions at the Policy workshop, suggested that:

- Science, extension, and innovation policies should be flexible and should evolve as new information and new capabilities are acquired;
- Policy makers must be strongly and consistently committed to developing innovative capabilities;
- Co-innovation programs need effective governance structures that allow innovators to influence decisions;
- Public research and extension institutions must recognize that they are not the leaders of innovation processes, but rather key supporting players;
- The good functioning of co-innovation depends on the presence of capable internal leadership and effective internal monitoring and evaluation;
- Efficient and combined use of, as yet, separate research and development resources requires early commitment in the policy and planning cycle at government level;
- Tools and instruments developed in the co-innovation approach in the HORTIN-II programme are relevant to be replicated in other programmes, such as the horticultural area development programme from the Directorate General of Horticulture.

2.2.3. Report
- 2009 Policy Workshop HORTIN-II Posters.
2.3. Meeting ‘Horticultural Research for Development’

2.3.1. Introduction
On the occasion of the end of the HORTIN-II programme in 2010, on November 29, a ‘Horticultural Research for Development’ meeting was organized at the Head Office of the Indonesian Center for Horticultural Research and Development (ICHORD) in Jakarta for farmers, representatives of small and medium enterprises, companies, traders, researchers, government officials and others engaged in horticultural research and development and supply chain management.

The aim of the meeting was to formulate lessons learned on how to successfully stimulate horticultural development. Results of several Indonesian-Dutch co-operation projects in horticulture were presented, amongst which the results of the HORTIN-II programme. Presentations were in Bahasa Indonesia with simultaneous projection of the text in English.

The meeting was opened by Dr. Yusdar Hilman, Director of ICHORD and by Mrs. N. Lintvelt, Head of the Economics Section of the Royal Netherlands Embassy, Jakarta. Mr. Wil Huisman attended the meeting as the official representative of the Ministry of Economic Affairs, Agriculture and Innovation of The Netherlands. After the presentation of project results, Dr. Ahmad Dimyati, former Director-General Horticulture of the Ministry of Agriculture of Indonesia, chaired the discussion and formulated lessons learned.

2.3.2. Conclusion
It was concluded that international co-operation is essential and valuable indeed to develop Indonesian horticulture. However, emphasis should be on long-term co-operation where partners learn to know each other well. Furthermore, for the future, co-operation in projects with several international partners is recommended.

For the HORTIN-II programme, the positive effect of co-innovation with farmers and small and medium enterprises was highlighted as a novel and effective approach. With the co-innovation approach, the projects were able to develop technologies relevant to the end users’ needs. It was recommended that the co-innovation approach be institutionalized in the Indonesian horticultural research and development system.

After lunch the meeting continued with a poster session of project results. Around fifty people attended the meeting.

2.3.3. Report
- 2010 End Meeting HORTIN-II Presentation English (E).
- 2010 End Meeting HORTIN-II Presentation Bahasa Indonesia (BI).
- 2010 End Meeting HORTIN-II Posters.
3. Evaluation

3.1. Organization and communication

3.1.1. Team meetings and reporting
The Dutch HORTIN-II team met two times a year to discuss planning of the work, progress in the projects and reporting at the year-end.

3.1.2. Reporting
Quarterly reports were prepared for the HORTIN-II coordinator, reporting on activities, progress, highlights and finances. Twice a year a full report on project activities was prepared for the management of the Cluster International Co-operation.

Regular contact and briefing on progress of the programme was maintained with the Agricultural Counselor at the Royal Netherlands Embassy, Jakarta and with the Policy Officer for Indonesia at the Ministry of Agriculture, Nature and Food Quality (now Ministry of Economic Affairs, Agriculture and Innovation) at The Hague.

Annual reports on progress of the HORTIN-II activities were prepared for the meetings of the Working Group on Agriculture and Forestry of the Ministries of Agriculture of Indonesia and The Netherlands.

During the programme period results were documented in Mission Reports, Research Reports, publications, leaflets and flyers.

3.1.3. Knowledge transfer
Direct and indirect transfer of knowledge has taken place in the programme through the active involvement of stakeholders in the respective projects. In addition to this, especially in 2010, in each project more formal progress workshops, trainings, demonstration fields and farmer’s field days were organized, to transfer knowledge to a broader public.
3.1.4. Co-operation
In general, activities in the HORTIN-II programme were carried out in good co-operation with all project partners, according to the yearly planned schedule. However, especially in the Supply Chain Development projects, the pace of progress sometimes slowed down, as it proved difficult to bring vegetable supply chain partners together to agree on common interests and to build trust and commitment for carrying out a pilot. On occasion, it took the Dutch researchers in these activities time to come to full communication and understanding of common goals and appreciation of the co-operation.

3.1.5. Visits
In 2007 three Indonesian project leaders visited The Netherlands in the frame-work of the preparation of the new HORTIN-II programme and to study co-innovation practices. In January 2009 two Indonesian project leaders visited The Netherlands, especially to discuss the further integration of crop based, technical projects and supply chain development activities. The Dutch HORTIN-II project leaders regularly visited Indonesia to carry out and participate in project activities.

3.1.6. Website
For easy communication and reference to the HORTIN-II programme, a website was build: www.HORTINII.org. On this website the aims of the programme and of the programme projects are presented, together with information on activities, published results and contact details. Project products are available on the website and will be available up to November 2011.

3.1.7. Flyer
A flyer for rapid introduction to the programme’s aims and activities was produced, updated and distributed. Short descriptions of the project are given together with contact details.

Product
• 2009 Programme HORTIN-II Flyer.
3.2. Main results and impact

3.2.1. Improvement of sweet pepper production technology to achieve competitive supply chains.
- Yields of sweet pepper can be increased considerably by using a wood-metal plastic house.
- The three stems per plant system results in the highest gross margin per m$^2$. The effect varies per variety, but the effect is between 1.5 and 2 kg yield per m$^2$.
- The variety Spider gives the best gross margin / yield per m$^2$. The yield is about 0.4 kg per m$^2$ more as the second best variety and about 1.5 kg per m$^2$ more as the poorest variety.

Impact: Improvement of yield and income.

3.2.2. Integrated pest management in sweet pepper.
- A permit for importing the predators *Amblyseius swirskii* and *Orius laevigatus* has been obtained.
- The knowledge of growers on pests and diseases in sweet pepper and on the safe use of pesticides has greatly increased and has resulted in more integrated pest management practices.
- Demonstrations with biological control have been carried out on two locations.
- A protocol for application of biological control by growers has been made.

Impact: Reduced pesticide use, quality of product meets export market demand.

3.2.3. Improvement of shallots supply chains.
- The TSS system is a realistic option to make shallot production in Indonesia more productive and competitive.
- Yields with the TSS system may double while costs increase only slightly.
- The use of seedlings instead of direct sowing results in a significantly higher yield.
- The new hybrid variety Sanren performs better than local variety Tuktuk.

Impact: Adoption of TSS technology, improvement of income, yield and product quality.

3.2.4. Hot pepper co-innovation development based on supply chain analysis.
- The use of a screen net in field production of hot pepper increases the yield more than 2 times, and possibly more, while considerably reducing pesticide use.
- The use of seedlings instead of direct sowing in open field cultivation is not economically viable.
- The use of seedlings leads to a positive effect on yield when the screen net is used.

Impact: Use of hybrid varieties comes within reach of farmers, higher income for farmers.

3.2.5. Quantitative Economic Analysis.
- All technical improvements in hot pepper lead to a 2.8 time increase in gross margin.
- All technical improvements in shallot lead to a 1.4 time increase in gross margin.
- For intercropped hot pepper and shallot, the combined results are a 2.9 time increase in gross margin.
- The combined result of the sweet pepper research is a potential range of 1.2 till 1.8 time increase in net farm income.

Impact: For all three vegetable crops potential income improvement was realized.
3.2.6. Supply chain development.
- As activities were mostly concentrated on sweet pepper, sweet pepper producers were the direct beneficiaries of the supply chain development activities.
- Investments in a modern wood-metal plastic house require capital or access to capital.
- The Indonesian horticultural sector should focus on import substitution.
- Benchmarking of the national IndoGAP standard with the international GlobalGAP standard is essential.

Impact: Increased awareness of the need, and capacities, to develop sustainable supply chains.

3.2.7. Product diversification and quality improvement of rambutan.
- Processing and preservation are the most promising options to extend the shelflife of rambutan.
- Processed rambutan can be stored at ambient temperatures (30°C) for 2 months. Rambutan juice can have a storage life up to 4 months.
- The application of modified atmosphere packaging and cold storage could improve the shelf life almost to 3 weeks.

Impact: Technology to extend shelflife of rambutan, and thereby the marketing season, is now available.
3.3. Impact of co-innovation

From the very start of the HORTIN-II activities, farmers, farmers groups, farmer’s co-operatives, small and medium enterprises, seed companies and supermarkets have been actively involved in the programme. By participating in the planning and execution of activities, and often by contributing in kind, they co-determined the direction of the project activities and contributed to the learning and development. The programme has succeeded to translate the concept of co-innovation systems into operational practices to solve problems along the supply chain. Moreover, the programme has answered the call for more integrated and practical research and development. By bringing together users and producers of knowledge as co-innovators, it realized new ways of generating and exchanging knowledge.

Product of co-innovation.
4. Conclusions

- The work on the co-innovations and technical improvements of crop production and crop protection in sweet pepper, shallots and hot pepper, yielded good and practical results. There was ample involvement of the end users, i.e. the farmers. Considerable attention was paid to transfer of knowledge to parties involved in the projects.

- The set-up and realization of innovative supply chains together with marketing parties, did not work out as well as envisaged, due the complexity of the situation and organizational considerations. Ample attention, however, was given to transfer of knowledge and capacity building with stakeholders on the various aspects of supply chain development.

- The co-innovation approach used in the programme showed promising potential to respond to the issue that competitiveness depends on collaboration for innovation in the whole chain of supply.

- The programme implementation offered lessons about how to foster horticultural innovation (see section 2.2. Policy Workshop).

- The final recommendation of the presentation of the HORTIN-II results (section 2.3.) was that the co-innovation approach should be institutionalized in the Indonesian horticultural research and development system.
5. Appendix

Overview of information on CD.

Acronyms.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>SweetPep</td>
<td>Improvement of sweet pepper production technology to achieve competitive supply chains</td>
</tr>
<tr>
<td>IPM</td>
<td>Integrated pest management in sweet pepper.</td>
</tr>
<tr>
<td>Shallots</td>
<td>Improvement of shallots supply chains</td>
</tr>
<tr>
<td>HotPep</td>
<td>Hot pepper co-innovation development based on supply chain analysis</td>
</tr>
<tr>
<td>QEA</td>
<td>Quantitative Economic Analysis</td>
</tr>
<tr>
<td>SCD</td>
<td>Supply chain development</td>
</tr>
<tr>
<td>Fruits</td>
<td>Product diversification and quality improvement of rambutan</td>
</tr>
</tbody>
</table>

1. Hortin II
   1.1. Inception report, presentation and flyer
   1.2. 2009 Policy workshop
   1.3. 2010 End meeting

2.1. SweetPep
   2.1.1. Mission reports
   2.1.2. Presentations
   2.1.3. Publications
   2.1.4. Research reports

2.2. IPM
   2.2.1. Mission reports
   2.2.2. Presentations
   2.2.3. Publications

2.3. Shallots
   2.3.1. Mission reports
   2.3.2. Presentations
   2.3.3. Publications
   2.3.4. Research reports

2.4. HotPep
   2.4.1. Mission reports
   2.4.2. Presentations
   2.4.3. Research reports

2.5. QEA
   2.5.1. Mission reports
   2.5.2. Research reports

2.6. SCD
   2.6.1. Mission reports
   2.6.2. Presentations
   2.6.3. Research reports

2.7. Fruits
   2.7.1. Mission reports
   2.7.2. Presentations
   2.7.3. Research reports