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Options for Greenhouse Horticulture in Malaysia

Trip report December 2008

Anne Elings & Jouke Campen

Wageningen UR Greenhouse Horticulture, Wageningen
December 2008

Rapport/Nota nummer

Picture front cover: Greenhouses in the Cameroon Highlands of Malaysia. The options for expansion are limited, and environmental concerns great.

Wageningen UR Greenhouse Horticulture

Adress : Bornsesteeg 65, 6708 PD Wageningen, The Netherlands
: P.O. Box 16, 6700 AA Wageningen, The Netherlands
Tel. : +31 - 317 - 47 70 01
Fax : +31 - 317 - 41 80 94
E-mail : glastuinbouw@wur.nl
Internet : www.glastuinbouw.wur.nl

Contents

1 Summary

We visited Malaysia as a follow-up to the mission in March 2008 by Anne Elings and Silke Hemming, in which the current situation was analyzed and identified opportunities for Malaysian Horticulture. The December mission was to :

1. Discuss with stakeholders in the public and private sector a greenhouse design that is suitable for Malaysian lowland and highland tropical conditions.
2. Brief AgroBank staff on the situation of and opportunities for Malaysian Greenhouse Horticulture.
3. Discuss with stakeholders the need for a knowledge training programme.

The major outcomes of the mission are:

1. Quotations will be made available to Sime Darby Plantation regarding the desing of a production greenhouse, and the design of a greenhouse for transgenics.
2. The greenhouse design as developed by Wageningen UR Greenhouse horticulture in in principle acceptable to the Ministry of Agriculture of Malaysia, and will be constructed at the commercial Serdang site.
3. Knowledge increase will be the very first step to deal with in the near future, to enable the cultivation of a good crop and a proper evaluation of the greenhouse design.

We thank Mr. Sulaiman Bin Md Zain and Mr.Cheah Lee Shen of the Ministry of Agriculture for organizing the workshop on Greenhouse Prototype Design (we will never forget the lunch…), various representatives of the private sector for their fruitful discussions and interest in horticultural activities, and Mr. Adrie de Roo, Mr. KC Chong and Mr. Luuk Runia for their hospitality and great help during our visit.

Wageningen, December 2008.

Anne Elings (anne.elings@wur.nl)
Jouke Campen (jouke.campen@wur.nl)

2 Introduction

This report results from the project "Tropical Horticulture in Malaysia", funded by The Netherlands Minsitry of Agriculture, Nature and Food Quality with project number BO-10-005-088.

2.1 Problem statement

Protected greenhouse horticulture is a growing activity in Malaysia that has been prioritized by the Malaysian government as an area of cooperation with The Netherlands. Also, the private sector sees business opportunities and initiates modernization. Traditional horticultural production takes place in the highlands, where land is scarce and production competes with tropical rainforest. However, ther are opportunities for modern horticultural production in the lowlands. For example, in Terengganu, greenhouses that are modern to Malaysian standards have been successfully realized in 2007. Most relevant crops are currently cucumber, chillies, sweet pepper and tomato; however, consumer's demand or export opportunities may lead to the introduction of other crops. It is desired that these first developments are taken further, also for the highland regions in the Cameron Highlands where the majority of horticultural production is located.

Protected greenhouse horticulture is therefore a promising area where public and private partners meet, that can contribute to employment. Business can be generated with protected greenhouse horticulture since is potentially allows to produce high-value per area surface. In order to achieve this, modernization of the sector is required in terms of:

- location-specific greenhouse designs, taking into account climatic conditions and required cooling system, and crop requirements;
- improvement of planting material;
- optimization of cultivation techniques;
- introduction of integrated pest management to substantially reduce use of pesticides and contribute to a lower environmental impact;
- design of above-mentioned components such that they form a well-balanced technology package;
- an enabling environment (government, research) that is conducive to the further development of the Malaysian horticultural sector;
- a Malaysian training and research capacity that can support the local horticultural industry in terms of farm management and production technology.

A mission was conducted in March 2008 by Anne Elings and Silke Hemming of Wageningen UR Greenhouse Horticulture. They analyzed the current situation and identified opportunities for Malaysian Horticulture ('Options for Greenhouse Horticulture in Malaysia. Trip Report March 2008, by A. Elings & S. Hemming).

The December mission by Anne Elings and Jouke Campen was a follow-up to this mission.

2.2 Terms of Reference Mission

The Terms of Reference of the March mission follow directly from the planned activities:

1. Discuss with stakeholders in the public and private sector a greenhouse design that is suitable for Malaysian lowland and highland tropical conditions.
2. Brief AgroBank staff on the situation of and opportunities for Malaysian Greenhouse Horticulture.
3. Discuss with stakeholders the need for a knowledge training programme.

3 Visits, workshop, meetings

All our visits were made in the presence of Mr. Luuk Runia, consultant to the Malaysian Agrifood Corporation Berhad.

3.1 Malaysian Agrofood Corporation (MAFC)

The new general manager of MAFC in the Cameron Highlands is Mohammed Mafar, with whom we briefly met.

At the MAFC facitities in the Cameron Highlands we were shown the new, Australian-built, greenhouse in which tomatoes were to be planted very soon. Some opservations:

- Plant density is 1.6 plants m^2 (one stem per plant), which is fairly low considering the tranporative cooling that is required.
- Longs slabs (over the entire length of the row) with cocopeat are used. The length may introduce the risk of easy spread of soil pathogens.
- One fertigation unit per 4 compartments may introduce problems when crops are in different development stages.
- One sensor in the centre of the compartment measures slab water characteristics near the root zone. This single value may not be characteristics for the entire compartment, however, leading to wrong decisions.
- The sample is transported a very long way to the sensors that are located in a building besides the greenhouse. This causes a long time period between sampling and analyzing, leading to delayed dicisions. Jouke will send Luuk some information on hand helt EC meters which are commercially available (done). Also information on stationed EC meters will be provided (done).
- The greenhouses lack a weather station.

3.2 Steel factory

A first prototype of the greenhouse design as presented previous visit was under construction at the Tong Yong Metal Sdn. Bhd. in Penang (the Northwest of the country). The steel factory is investing at own costs in the construction of the prototype, envisaging a domestic substantial market in the future. We indicated some modifications, especially with regards to the vent opening in the top, to ensure sufficient ventilation capacity without the risk of rain water coming into the greenhouse. The prototype consisted of one span of 6.4 m wide, 5 m long and 4 m high at the gutter. Side nets and nets in the ventilation opening in the top will allow sufficient ventilation during periods with and without wind. During periods with wind the pressure difference is the driving force for the ventilation. In case of minimal wind the buoyancy effect will stimulate the ventilation.

We urged the constructor to use foil that blocks NIR (near-infrared) radiation and that transforms direct into diffuse radiation. Blocking NIR reduces the inside temperature, and transforming direct into diffuse radiation lowers inside temperature and causes deeper penetration of the light in the canopy, which enhances photosynthesis. A haze film slightly reduces the transmissivity of the film but since the light coming through is used more effectively the net effect is positive in terms of production.

Final prototypes will be evaluated at the MAFC site in the Cameron Highlands, and at the MARDI experimental station in Serdang. The exact dimensions are not yet know. The design is based on a prototype build in Indonesia where it is build as a single span. The current greenhouse will be build as a multispan which has a major effect on the greenhouse climate. Jouke will do some preliminary CFD calculations to determine the effect of a multispan on the greenhouse climate given the current design.

We urge that at whatever site the construction is evaluated, a weather station is required to actually measure the performance of the construction. The data gathered by the weather station should minimally consist of (1) air temperature, (2) relative air humidity, (3) global radiation, (4) direct radiation, (5) rainfall, (6) wind speed and (7) wind direction. Usually, these data come at an interval vo 5 minutes.

3.3 Sime Darby

We met with Dr. K. Harikrishna and Mr. Gene Goh of Sime Darby Plantations. This was a follow-up of our previous visit to the production facilities at Seremban, and Mr. Gene's visit to Wageningen in July 2008.

Sime Darby is one of the largest food companies in Asia, and the larges Malaysian Company at the stock exchange. In The Netherlands it owns UniMill. Sime Darby deals with 5 core areas:

- property
- motors distribution
- oil and gas engineering
- energy utilities
- plantation and food

In addition, it is engaged in a number of non-core areas:

- health care
- hotels
- golf courses

Plantation and food consists of a number of activities:

- Oil palm plantations provide 70% of the total profit, and are therefore a very important activity. Total of 540 000 ha.
- Growing of vegetables under tropical conditions.
- Repackaging and rebranding (e.g., sauces, soft drinks).
- Rice cultivation is small scale at the moment. The company tries to develop a model farm of 200 ha in the northern corridor.
- Food is a small activity, and consists of processed materials.

Sime Darby is interested in two types of greenhouse constructions:

- A greenhouse construction for the commercial production at 30 acres (about 15 ha) at Kerry Island and at xxx in the tropical lowlands. The requirements for this greenhouse construction are as follows:
    - Aeroponics / Hydroponics
    - Cost effective
    - Stable production under variable radiation and temperature conditions
    - Collection and recycling of rainwater. Note: rainwater is mostly of good quality, except for the water that falls during the first minutes and can contain toxic elements. In any case, water treatment with reverse osmosis (more expensive) or natural filtration (best option) is necessary.
    - Use of renewable, solar energy. Note: use of solar energy is still not cost effective, and therefore conflicts with the cost effectiveness.
    - Control of air flow. This requires a good ventilation capacity.
    - Use of CO_2 from a nearby power plant
    - Minimization of pesticide use
- A greenhouse construction for transgenic activities. The requirements for this greenhouse construction are as follows:
    - Glass cover, full closure
    - High cooling capacity, but as energy efficient as possible
    - 100 * 120 m = 1.2 ha, compartmetized
- A greenhouse for research on lowland rice, or seedling raising, was not brought forward.

Sime Darby stated that there is a major lack of expertise for greenhouse management. Also on the point of IPM not a lot is known.

WUR will cooperate on a consultancy basis and will prepare a quotation. For a good design, frequent climate data are required. [Offerte gaat dus uit van beschikbaarheid van goede klimaatgegevens]

Mr. Gene Goh will send the exact details for the greenhouses to be constructed.

3.4 Agrobank

A presentation on 'Options for Greenhouse Horticulture in Malaysia' was given to Mr. Any Rengkai Ak Uchop and a number of staff members. The presentation focused on the potentials of protected cultivation in Malyasia, on the currents situation, ways forward, with special attention to the role of credit. A well-functioning credit system enables entrepreneurs to invest in new technology and make a technological step forward. The write-off period should be a substantial number of years; one or only a few years will not be enough to pay back the loans that are required for the necessary investments.

3.5 Workshop on 'Greenhouse Prototype Design'[1]

The Ministry of Agriculture (MoA) organized in the framework of the 'Malaysia-Netherlands Bilateral Cooperation Project' a workshop on 'Greenhouse Prototype Design'. Representatives from the Ministry of Agriculture (MoA), Malaysian Agriculture Research and Development Institute (MARDI), University Putra Malaysia (UPM), Malaysian Agrifood Corporation (MAFC), the Netherlands Embassay, Wageningen UR Greenhouse Horticulture, and others participated. The purpose of the workshop was to come to a greenhouse design that is suitable for Malaysian lowland and highland growing conditions.

Workshop programme:

1. Opening by Suleiman Bin Md Zain, DDG (Operations), DoA.
2. Word of thanks by Adrie de Roo, Agricultural Councellor at the Netherlands Embassy.
3. Status of Fertigation Technology Adoptio in Permanent Food Production Parks, by DOA staff.
4. General Introduction by Anne Elings
5. Group-wise brainstorm on expectations and desires with regards to greenhouse design.
6. Grouwp-wise brainstorm on limitations with regards to greenhouse design.
7. Technical Introduction by Jouke Campen.
8. Plenary discussion on final greenhouse design.
9. Wrap-up session by Suleiman Bin Md Zain, DDG (Operations), DoA.

A summary of the expectations and desires with regards to greenhouse design:

- Optimum management of the micro-climate (CO2, RH, temperature, radiation).
- Supporting good overall plant management.
- Good ventilation is crucial, for example through good vent opening in the roof. In this respect size of the mesh in the insect net was mentioned. The surface area of the screen has to be large enough to compensate for the reduction in ventilation.
- Consider the amount of spans, the height of the construction, and the orientation of the construction.
- Use galvainzed iron.
- Plastic cover that blocks UV and NIR.
- Use shading material outside the construction.
- Prevent that irrigation tubes are exposed to direct sunlight and heat too much.
- Use a fully irrigates system.
- Verify the supplied material. Consumers do not know whether the supplied material is in conformity with the specifications given. A simple test method should be developed.
- The construction should be strong and durable, and be able to withstand a maximum wind speed upto 130 km/h.
- A draining system with water recycling.
- Maximum automation.
- Solar energy.
- On the ground, good plastic that is white at the top and black at the bottom must be applied. Concrete must not be applied – this retains heat.
- Computerized data collection, especially with regards to the nutrient and water balance.
- Precision, high-frequency fertigation.
- Grow-bag system, which prevents the spread of root diseases.
- Use clean, certified seeds.

A summary of the limitations with regards to greenhouse design:

- Climatic conditions, especially temperature and RH.
- Maximum costs should be around 750 000 Rg/ha. It was remarked to also consider the net costs, viz. the investments reduced by the increased profit due to higher production.
- No specialized manufacturer, and no back-up services.
- Lack of special lowland, heat resistant, varieties.
- Lack of knowledgeable workers, managers and operators. An 8-month training course was given but the success rate was very low. There was a lack of discipline.
- Land scarcity in the highlands, so move to the lowlands.
- Low quality of the surface water. Use of (expensive) ground water.
- High fertilizer costs. Fertilizers made in China are not good enough.
- The marketing system does not know premium pricing for sustainable production.
- Low quality awareness of consumers. Quality is not paid. Food safety is not an issue at the moment for the Malasian consumers.

[1] A complete workshop report will be prepared by the MoA.

- No networking among farmers.
- Biological pest management not possible.

The discussion resulted in the following major outcomes:

- The Netherlands Government has initiated activities with seed money. The MoA is now taking over. Regular meetings are held to deal with emerging problems. A column approach is followed, in which is started with the primary production.
- The prototype greenhouse design as presented by Jouke Campen is in principle acceptable by the DoA.
- Some modifications may be required, following the workshop discussion and evaluation of the design by DoA.
- The prototype greenhouse will measure some 5000 m2, and be built in the commercial area of Serdang. A rough calculation indicates that the construction plus installation and other costs should fall within the budget that DoA has available.
- The MoA has available a budget of one million Ringgit. The estimated construction costs of the greenhouse are 100 Rg m-2. A greenhouse of 5000 m2 would therefore cost 0.5 million Rg, leaving another 0.5 million Rg for installation equipment and goods such as fertilizer.
- WUR will send you within 3 weeks time (by December 25th) the technical drawing. If possible, WUR will add a more precise cost estimate (if not, this will follow as soon as possible).
- DoA will establish a committee that will finalize its judgement on the technical drawing by February 2009.
- We then will finalize the technical drawing within a matter of weeks.
- Construction can then start, which should last not more than one month.
- The first crop can be planted in June 2009.
- There is a major knowledge need in various fields. Ways will be searched to deal with this at short notice, in order to enable the cultivation of a good crop and a proper evaluation of the greenhouse design.

3.6 Netherlands Embassy

With Adrie de Roo, Agricultural Councellor at the Netherlands Embassy in Kuala Lumpur it was agreed that the 2009 activities would concentrate on two issues:

- realization of the demonstration facilties
- development of a plan for knowledge increase

Annex I.

Itenary

Sa 30 Nov	evening	Departure from The Netherlands
Su 1 Dec	Afternoon - evening	Arrival to Kuala Lumpur; pick-up by Luuk Runia, drive to Cameroon Highlands; check-in at Centtury Pines in Tanah Rata
Mon 2 Dec	morning	Visit to the Tong Yong Metal Sdn Bhd steel factory at Penang
Tue 3Dec	morning	Visit to MAFC Cameroon Highlands General Manager Visit to new MAFC tomato farm
	afternoon	Travel to Kuala Lumpur
	evening	Dinner with KL Chong and Jan Fongers
Wed 4 Dec	morning	Meeting with xxxK. Harikrishna and Gene Goh of Sime Fresh Plantation
	afternoon	Meeting with AgroBank staff
	evening	
Thu 5 Dec	Morning + afternoon	Workshop on greenhouse design
	evening	Dinner with Adrie de Roo
Fri 6 Dec	Morning + afternoon	Free time
	evening	Departure to The Netherlands

Annex II.

Persons met with

Name	Position	Address	Email / web	Telephone/fax
Luuk Runia	Consultant			
Adrie de Roo	Counsellor for Agriculture, Nature and Food Quality	Embassy of the Kingdom of The Netherlands Agricultural Office The AmpWalk, 7th floor, South Block 218 Jalan Ampang, 50450 Kuala Lumpur	adrie-de.roo@minbuza.nl www.netherlands.org.my	T: +60 (0)3 21686206 F: +60(0)3 21686240
K.C. Chong	Technical Assistant	Embassy of the Kingdom of The Netherlands Agricultural Office 541 Orchard Road 13-01 Liat Towers, Singapore 238881	Kc.chong@minbuza.nl	T: +65 67391121 M: +65 96311986 F: +65 67371940
Ng Hong Liang	Director	Tong Yong Metal Sdn. Bhd. Lot 5779 & 5780, Jalan Seladang, Alma, 14000 Bukit Mertajam, S.P.T. Penang	tymhl@tm.net.my	T: +604 5523086/89/90 F: +604 5523087
Kenny Lim P.T.	Marketing Executive	Tong Yong Metal Sdn. Bhd. Lot 5779 & 5780, Jalan Seladang, Alma, 14000 Bukit Mertajam, S.P.T. Penang	kennylimpt@gmail.com	T: +604 5523086/89/90 M: +60 124755772 F:+604 5523087
Wong Seng Yee	Management	TreeGrow B-46, Bertam Valley, Ringlet, Cameron Highlands, 39200 Pahang	treegrow@treegrwo.com www.treegrow.com	T: +605 4957291 F: +605 4957290
Mohammed Mafar	General Manager	Malaysian Agrifood Corporation, Cameron Highlands		
K. Harikrishna	Senior Vice President II Head, R&D Quantum Leap		Harikrishna.k@simedarby.com www.simedarby.com	T: +603 77878900/01 M: +60 192786728 F: +603 77810298/30
Gene Goh	Assistant Manager Sime Darby	Sime Darby Technology Centre Sdn. Bhd. 2, Jalan Tandang 46050 Petaling Jaya Selangor	gohgsb@simedarby.com www.simedarby.com	T: +603-77878918 M: F: +603-77810230
Andy Rengkai Ak Uchop	Special Officer to President Head of International Unit	Agrobank Leboh Pasar Besar, PO Box 10815, 50726 Kuala Lumpu	Andy@agrobank.com.my www.agrobank.com.my	T: +603 27311600 ext 1310 M: F: +603 26934948

Cheah Lee Shen	Deputy Director of Horticulture (Fruit) Horticulture Division Department of Agriculture Malaysia	10th Floor, Wisma Tani, Lot 4G2, Precint 4 Federal Government Administration 62632 Putraya	cheahls@doa.gov.my www.doa.gov.my	T: +603 88703406 M: +6017 5133860 F: +603 88703460
Suleiman Bin Md Zain	Deputy Director General of Agriculture (Operation) Department of Agriculture Malaysia	10th Floor, Wisma Tani, Lot 4G2, Precint 4 Federal Government Administration 62632 Putraya	sulaimanmz@doa.gov.my www.doa.gov.my	T: +603 88703005/6 M: +6012 4076600 F: +603 88888284
Engr. Dr. Mohammud Che Husain	Deputy Director at Malaysian Agricultural research and development institute	PO Box 12301, 50774 Kuala Lumpur	mch@mardi.gov.my	T:+60389437230 F: +60389482961
Mat Sharif Ismail	Research Officer at Malaysian Agricultural research and development institute	PO Box 12301, 50774 Kuala Lumpur	masharif@mardi.gov.my	T:+60389437546 F: +60389482961
Erymarini Binti Mustafa	Envisaged Greenhouse Manager Serdang Station Department of Agriculture Malaysia	Komoditi Serdang	erymarini@gmail.com	

Annex III.

Photographs

Figure 1. The first prototype of the greenhouse constructed at Tong Yong Metal Sdn. Bhd..

Figure 2. Dr. Sulaiman Bin Md Zain, DDG of Agriculture (Operations) of the Ministry of Agriculture, presiding over the Workshop on Greenhouse Prototype Design (left), and an impression of a discussion group gathering (right)..

Annex IV. Presentation 'Options for Greenhouse Horticulture in Malaysia'

Presentation given to Agrobank, and at workshop
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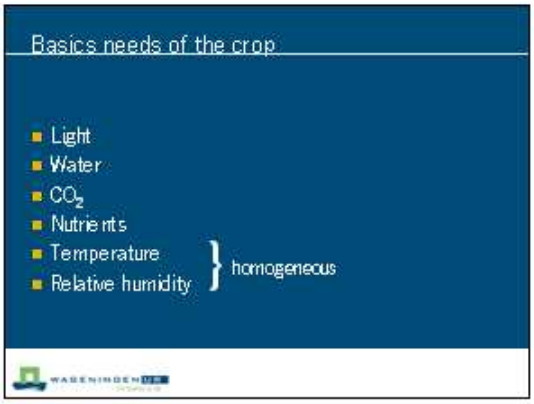
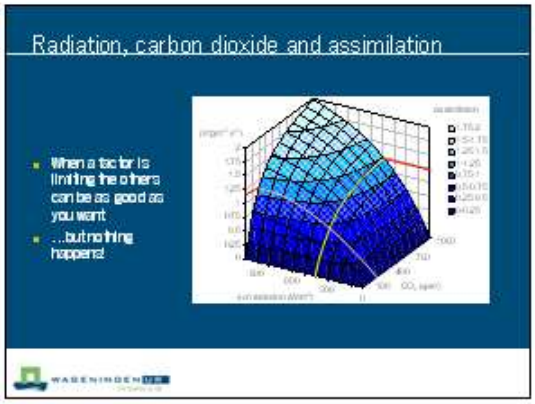
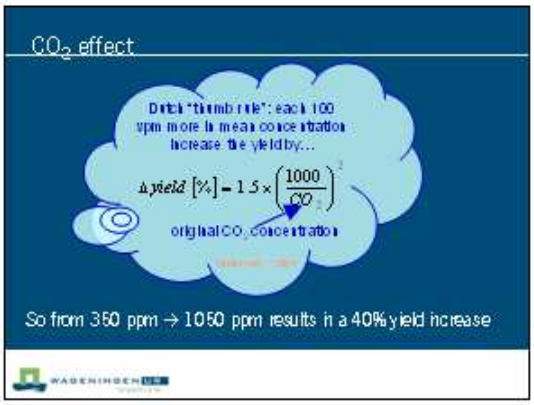
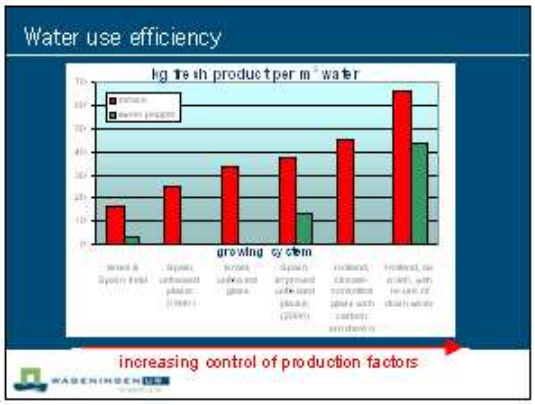
Annex V. Presentation 'Greenhouses for tropical climates'

Presentation given at workshop





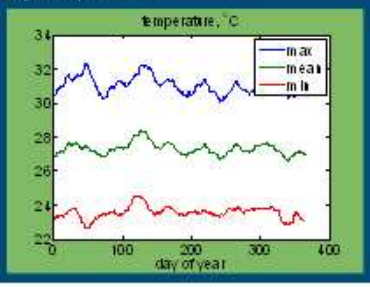




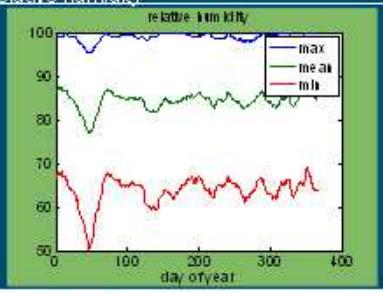
Climate control

- Climate analysis
- Cooling methods
- Covering material

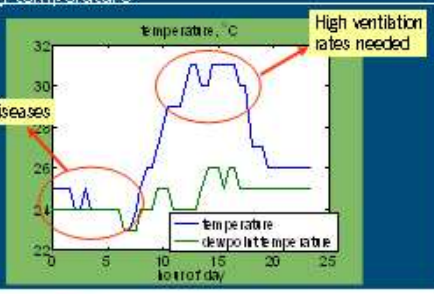
Yearly temperature



Relative humidity



Daily temperature



Climate conclusions

- Outside temperature is within limits but the greenhouse has to be ventilated extensively
- Evaporative cooling is done by the crop

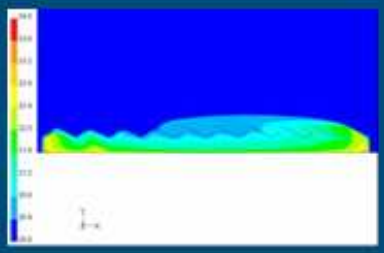
Presentation

- Climate analysis
- Cooling methods
- Covering material

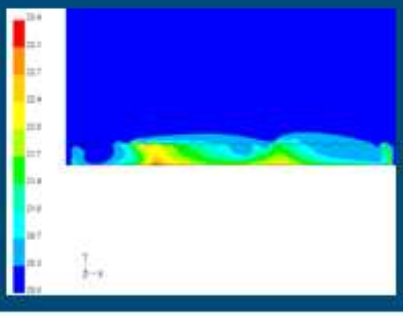
Ventilation

- Wind effect
- Buoyancy effect
- Mechanical ventilation

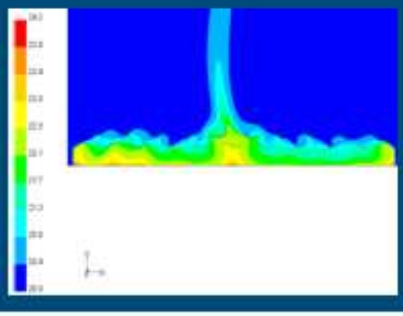
Lee side ventilation



Wind side ventilation



Buoyancy effect



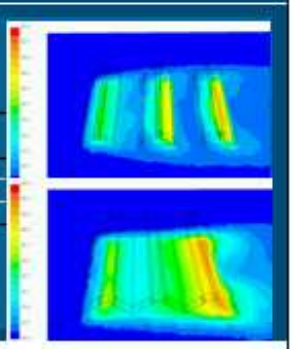
Indonesian design

CFD

- Single greenhouses
- Wind 3m/s

Configuration	3 m/s wind	No wind
single greenhouses	31.3	33.5
	31.4	33.6
	31.3	33.6
multi-span	32.1	33.8

- Multi-span
- Wind 3 m/s



Mechanical ventilation

Vents in the side

Energy demand

Global radiation in the greenhouse is 500 W/m2

Sensible heat is 250 W/m2, temperature difference of 5 degrees

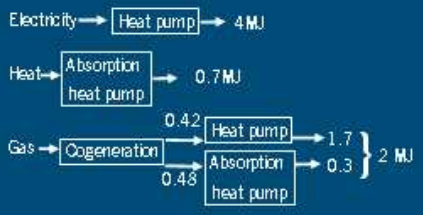
$$\frac{250 \times 3600[J]}{1200 \times 5[J/m^3]} = 150 m^3/m^2 h$$

30 m^3/m^2h^1 cost 1 Wh

Possibilities for active cooling

- Using a chiller
- Evaporative cooling
- Using cold sea water

Active cooling methods



Presentation

- Climate analysis
- Cooling methods
- Covering material

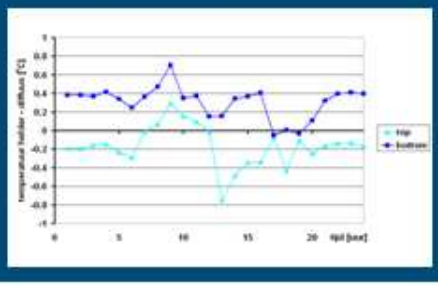
Covering material

Important issues

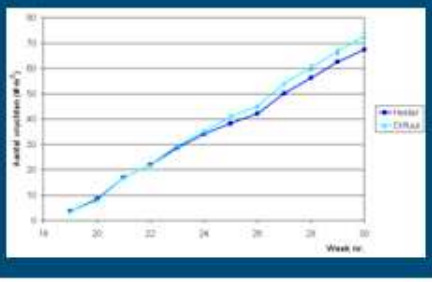
- Light transmissivity
- Insulation properties → Keeping heat outside
- Spectral reflectance → keep UV en NIR radiation out
- Haze properties → Making direct radiation diffuse
- Cleaning methods
- Durability
- Wind conditions / sand → Strength of the material

Covering material : diffuse light

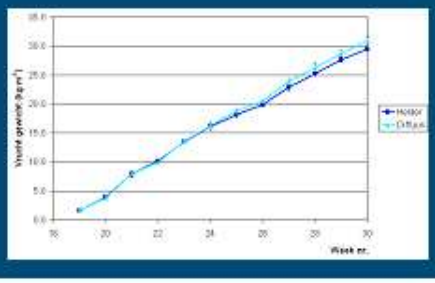
Temperature of the crop

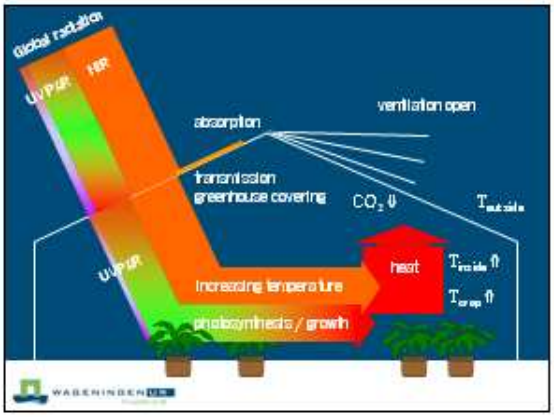


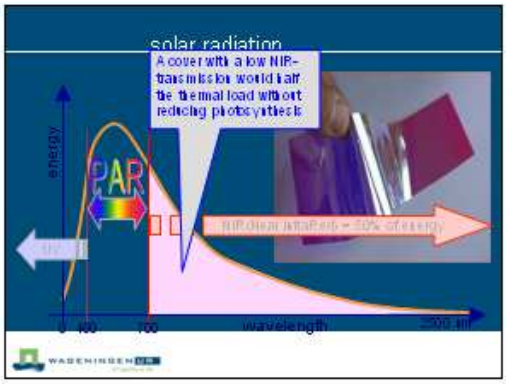
Number of cucumbers



Production






solar radiation
A cover with a low NIR-transmission would halfthe thermal load without reducing photosynthesis
energy
PAR
wavelength


Wageningen UR Glastuinbouw
Innovaties vóór en mét de glastuinbouw
Email: Jouke.campen@wur.nl