出國報告（出國類別：研習）

出國報告題目: 105 年選送技專校院教師赴國外實務研習

服務機關：國立高雄第一科技大學
姓名職稱：教授
派赴國家：荷蘭
出國期間：105 年 9 月 5 日 至 109 年 9 月 23 日
報告日期：105 年 10 月 3 日

1、目的

本次出國為參加「105 年選送技專校院教師赴國外實務研習」，至荷蘭瓦罕寧恩大學學習三週的高強度課程。此次課程的中心目的是溫室作物管理技術，其中包含了各領域之照明、溫度、熱力學、流場、植物生理、土壤物性、養液調整、簡單控制、品質、設計、及採收後管理等不同的深入課題。此次課程讓我們充分瞭解及掌握溫室栽培所需的技術及方法，對農業現代化的助益良多。本次教師實務增能培訓計畫，期望團隊教師能透過此研習課程之學習歐洲進行智慧農業 4.0 成果，達到：

(一) 共同編輯農業生產力 4.0 學分學程教材。
(二) 農業生產力 4.0 學分學程種子教師。
(三) 培育農業生產力 4.0 人才。
(四) 共組跨校團隊，針對農業 4.0 議題進行相關研發。

2、過程

教育部選推出國為參加「105 年選送技專校院教師赴國外實務研習」教師實務增能培訓計畫，培訓學校為：荷蘭瓦罕寧恩大學(Wagenigen University，簡稱 WU)，其為荷蘭 14 所研究型大學之一，在荷蘭高等教育高居榜首，亦是歐洲發展農業技術最具代表性的大學之一，在農業學科方面的研究機構中排名:世界第二，故期望團隊教師能透過此研習課程之學習歐洲進行智慧農業 4.0 成果，研習時成為三週。此次課程的中心目的是「溫室技術」，其中包含了各領域之太陽光能、溫室之設備、照明、溫度、熱力學、空氣流場、設計模擬、氣候管理、植物生理、土壤物性、養液調整、簡單控制、品質、及採收後管理等不同的深入課題。參觀溫室建置廠商、溫室控制設備(氣候和水管理)、包裝材料塑膠吹膜廠商、植物盆製作塑膠熱壓成型場、育種苗場、荷蘭花卉拍賣場、花卉產銷公司、瓦罕寧恩大學產學園區、蘭花及火鶴種植場、此次課程讓我們充分瞭解及掌握溫室栽培所需的技術及方法，對農業現代化的助益良多。

第一週：專業課程研習(一)

Day	Morning(8:30 -12:00)	Lunch	Afternoon(13:00-17:00)
Monday	Introduction to Protected Horticulture		
Tuesday	Passive greenhouse (functions of the cover and natural ventilation)		
Wednesday	Crop physiology and Crop Management		
Thursday	Natural ventilation		
Friday	Root zone Management		

第二週：專業課程研習(二)

Day	Morning(8:30 -12:00)	Lunch	Afternoon(13:00-17:00)
Monday	Crop physiology and Crop Management		
Tuesday	Optimal Climate management		
Wednesday	Energy engineering & Systematic design		
Thursday	Root zone Management		
Friday	Systematic design &seminar		

第三週：產業研習

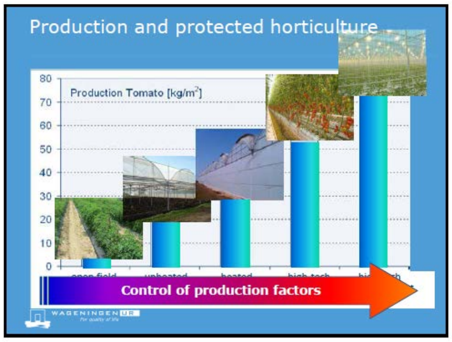
Day	Excursion to grower companies and equipment suppliers
Monday	Auction, trading
Tuesday	Climate and water management
Wednesday	Light management, Greenhouse building
Thursday	Packaging, plastic film
Friday	Young plant production, breeding
Related fields: Mechanical engineering, environmental engineering, agriculture, biotechnology, production management, marketing, horticulture, materials, electrical, optical, industrial design, information management	

上課心得筆記:

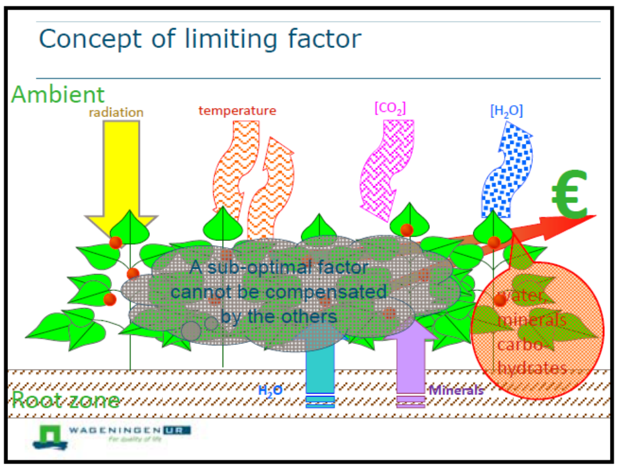
氣候管理

Climate management: the ‘passive’ greenhouse

Dr Cecilia Stanghellini/Wageningen UR Greenhouse Horticulture, Wageningen, NL



植物生長受到限制的條件有日照、溫度、二氧化碳、水、營養等。而這些要素很難用其中一項來取代另一項。Concept of limiting factor: ambient: radiation, temperature, CO2, H2O; root zone: H2O minerals; a suboptimal factor cannot be compensated by the others



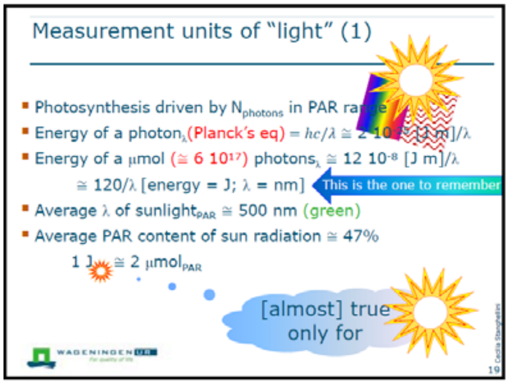
我們表示產能是以每平方公尺的產出濕重，而生產力是表示為每百萬焦耳的產出乾重。Marketable yield: kg/m2 relates to cumulative solar radiation: MJ/m2 (3000-5000); productivity: g/MJ (Almeria 7.8 g/MJ, Sicily 5.6 g/MJ, Sicily tunnel 3.4 g/MJ DM)。

其中 PAR=Photosynthesis Active Region (400-700 nm)

，NIR=near infrared=50% of energy

注意: 1000 W/m2 for one hour = 1000 J/m2 *3600 s/h = 3.6 MJ/m2 (W=J/s)

並且 Energy of a micro mole photons (6x10^17) = 12x10^-8 Jm/lambda = 120/lambda (energy:J, lambda:nm)



Average lambda of sunlight at PAR = 500 nm (green)

1 J_sun = 2 u mol_PAR in avg

HPS (high pressure sodium)

epsilon: emissivity of material surface (leaves and water=1; aluminium=0.03)

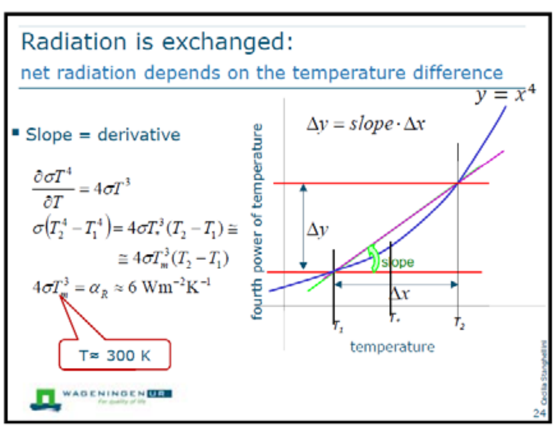
Wien's law: the colder the thing, the longer the wavelength of the emitted radiation

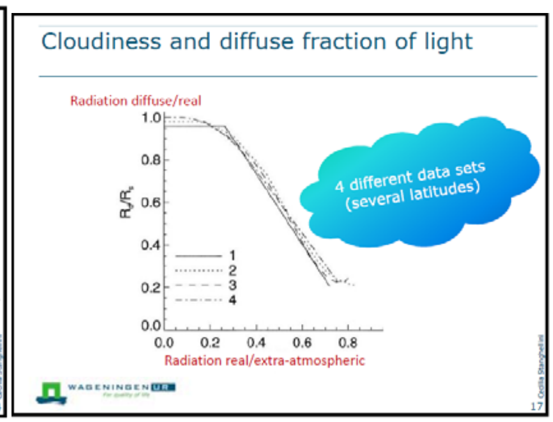
淨幅射與溫度差有關 Net radiation depends on the temperature difference

Average Holland daylight radiation intensity 120-220 umol/m2s (typical 150) (700 W/m2)

能量流密度 Energy flow density (W/m2) = alpha_c (T_g –T_a); alpha_c (W/m2K)=2.8+1.2u (wind velocity); Ta ambient temperature; Tg greenhouse temperature; tau: light transmissivity 70%

For cover and screen design (tau lo epsilon): tau_PAR as high as possible; lo_NIR high to cool, low to warm; epsilon_IR low to warm (aluminum), high to cool (whitewash)





Climate management: temperature, humidity and carbon dioxide

Cecilia Stanghellini /13 Sept 2016

本節課有關於 1. Effect of greenhouse covers; 2. Energy balance of a closed "tunnel"

Isun = radiative losses + sensible heat loss through the cover ±

sensible heat & radiation to/from the soil

植物生長為生物質量加上光合作用 Crop growth = biomass production + photosynthesis (carbon dioxide + light)

植物生長增重與溫度有關 Crop development = formation of new organ (temperature)

通氣率的單位是每平公尺小時所換出的氣體體積 Ventilation rate unit = m3/m2h

溫室中的溫度是氣候及腹蓋物的函數 Tunnel temperature = f(climate, cover properties)

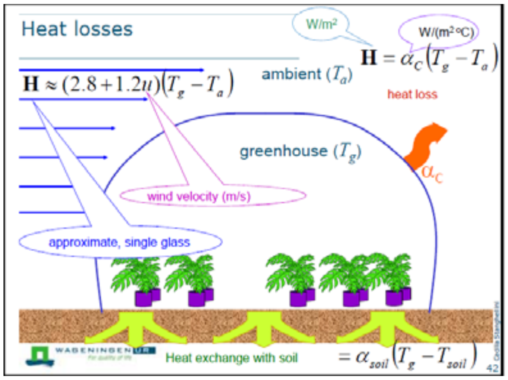
通風能力是面積及窗口大小形狀所決定 Ventilation capacity (area and position of opening, shapes)

其中也包含開口大小、風速、溫度差、濕度梯度等。Prevailing conditions: rate of opening, wind field, temperature and humidity gradient from inside to outside

蒸氣比一般空氣輕 Vapor air is lighter (molecular mass of air=29, vapor=18, CO2=44)

在需要加熱時，外部風速高時，能量損失也大 Energy load is higher at higher wind velocity

溫度管理=開口大小管控+光源供給需求平衡 Temperature management = variable opening + good source-sink balance



換氣率並不於開口大小等比，在開口小時，通氣改變較大。Ventilation rate is not linear to the flap opening angle (parabolic): small opening can give significant temperature control

Velno 式的峡長設計，使得換氣率較能得到控制。Velno greenhouse is better in ventilation because 4m narrow span causes smaller flap opening

供給限制是指高溫但低照度，植物得不到所需的光照; 需求限制是高照度但低溫，植物不需要這麼多光照。Too high temperature low light (source-limited), too much light low temperature (sink-limited)

光照、溫度、及二氧化碳需要一起增加。Optimal temperature increase with light (and with CO_2 concentration)

Ventilation rate is set with inversely proportional to the temperature error and P should be large

Holland is at 52 degree of latitude, westland

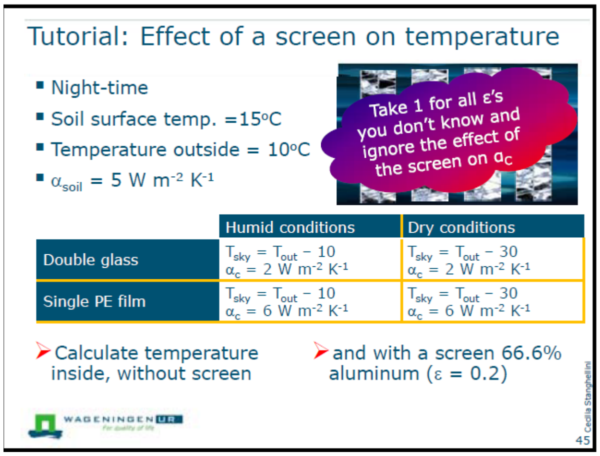
荷蘭在冬天播種，在秋天收成。Traditional growing cycle at Holland is based on nature radiation-temperature cycle: seeding, transplanted at winter and harvest at autumn

南西班牙在秋天播種，在 5 月收成。Growing cycle at south Spain Almeria reverse the cycle, seeding at august and harvest in May.

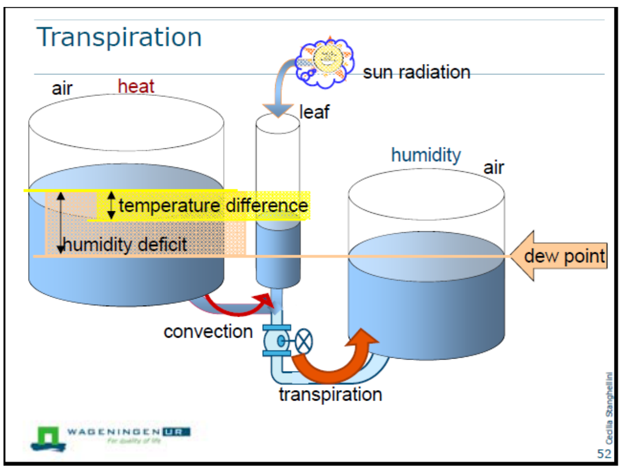
差的溫室每平方米每年只生產 10 公斤的蕃茄。Poor greenhouses only produce about 10kg/m2/year of tomato

好的溫室每平方米每年可以生產 15 公斤的蕃茄 (我們台灣可以生產多少呢?)。Good ventilated greenhouses produce about 15 kg/m2/year (windy areas induce more air flow)

良好的遮敝可以減輕通風的負擔。Using shading (whitewash or screening) decreases the need for ventilation capacity.



Transpiration depends on Humidity



Vapor concentration Chi (g/m3) and specific humidity q (g/kg) is a constant times vapor pressure e (kPa)

Temperature to saturated vapor pressure e* is exponential.

Evaporation rate (g/m2h) = mass flow rate + condensation rate

V = Phi (Chi_in – Chi_out), ventilation (m3/m2s) Chi (g/m3)

Remove vapor amounts to remove energy (latent heat of vapored water = 2500 J/g) (specific heat of air = 1200 J/kg.K) (density of air = 1.2kg/m3)

* The purpose of humidity control is to prevent condensation on the crop (humidity has no direct relationship between transpiration and growth, indirect with light)

Transpiration depends on temperature difference and humidity deficit (the temperature of leaf should be lower than the dew point) (we want leaves cold than air but higher than dew point) (condensation provide energy to leaves)

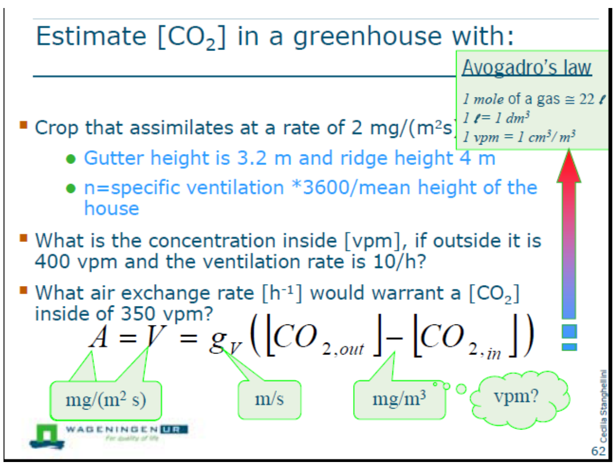
At nighttime, dew point is almost identical inside and outside for well-ventilated greenhouse. Thus ventilation will not bring down the humidity down. Conversely, for a unventilated greenhouse, dew points are higher and crops are less likely to have condensation.

To increase dew points: ventilation if help, condensation (with alumni), air conditioning

Air circulation: bring heat and cold out of leaf surfaces.

Larger leaves are poor in heat exchange because of air boundary.

二氧化碳管理 Carbon dioxide management



Assimilation consume CO2 so that inside concentration is lower; gradient exists. Ventilation is the only way to take in CO2.

A depletion in CO2 loss in assimilation and then loss in yield significantly.

Assimilation is a function of both light intensity and carbon dioxide; net income is proportional to the assimilation.

Tomato seedling example: 1 kg of assimilated CO2 produces 500g, amounts to 5kg fresh weight for 10% d.m.; 10 g/seedling = 500 seedling; ~350 EU/kg assimilated

Greenhouse Technology/Energy and climate engineering (I)/Basic principles for control of temperature and humidity

Bert van ’t Ooster, Thursday 8 September 2016

氣候管理所需要設定的參數，例如溫濕度，一般都是農民的私有知識，主觀但不見得有效。Climate control is used for green finger’s private knowledge

GR=LUE*PAR*C_T*C_CO2

Enthalpy h = c_da *T_db + x(L+c_v * T_db); x=specific humidity, L=heat of evaporation of water at 0 C)

Source of cold: 1. adiabatic cooling or contact cooling (water flow on glass surface); 2. Heat pumps; 3. Cold recovery systems (heat exchange)

Performance of ventilation Phi = f(Delta T, wind speed, window opening)

Natural ventilation cannot achieve temperature that is lower than outside temperature.

Evaporative cooling: nozzle(revolving discs or brushes, high pressure fog, air water nozzle (low pressure);

Adiabatic cooling: pad and fan cooling: sucking fan is not good because warn air is sucked in; pushing fan

Psychrometrics = VPD curve

Humid air flow up and dry air deposit down

Dehumidification: condensation on finned pipes or cold surfaces

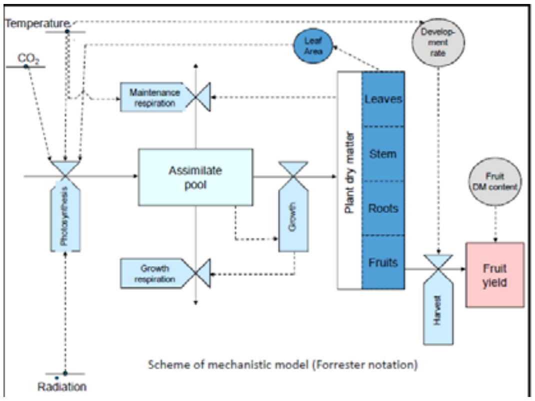
Temperature efficiency of a heat exchanger: eta = (T_inlet-T_e)/(T_i-T_e); T_i cold input temperature, T_e warn input, T_inlet output of heated medium (outlet to the system of interest), T_out output of cooled medium (output of the system of interest)

Reducing ventilation in order to preserve energy, water, and CO2. Solar heat collection and storage is possible. But excess heat and vapour must be removed.

Using latent heat converter to reduce minimum ventilation.

Seasonal Thermal energy storage: summer->winter in aquifers

Heat pump: coefficient of performance COP=cooling energy/consumed energy



作物管理

Yield component analysis: light interception, light use efficiency (LUE)

Instructor: Ep Heuvelink\Wageningen University 7 September 2016

Fresh weight = with water/Dry weight = without water

植物生長分析: 光合作用與形狀作分開計算: Plant growth analysis: (distinguish between photosynthetic effects and morphogenetic effects); for young plants: w_t = w_e e^ (rt) for dry matter (r=relative growth rate)(RGR)

相對成長率: GRG (g/gd) = 1/LA dw/dt LA/W = net assimilation rate * leaf area rate

其中 LAR = LA/W_l * W_l/W = specific leaf area * leaf weight rate = SLA * LWR; W_l leaf dry weight; W plant dry weight

對於植物接受光照之後所產生作用可以表示為: LUE (g/MJ) = TDM/intercepted PAR; total dry matters are measured without water; intercepted PAR = 1-e^(-k LAI)

因此整株植物的成長速率為 dW/dt (gDM/m2d) = LUE (gDM/MJ_PAR) (1-e^(-k LAI) I (PAR on crop MJ/m2d); k=extinction coefficient

例如: light on top of canopy: global radiation: 300-3000 nm; PAR: 400-700 nm; in day light PAR=0.5*global radiation; in greenhouse PAR=0.7*PAR outside; 20 MJ/d outside = 7 MJ/d in a greenhouse

而最後收成果實時，果實的乾重只佔整體植物乾重的一個固定百分比。

Production in the fruit stage: from anthesis to breaker to harvest and ripe

Increase growth per 100 ppm in CO2 = 1.5M/CO2^2

Water quality aspects/ pH and EC, water quality, salinity

Wim Voogt

Electric conductivity:

ions: N+ K+ S- (Ca+, Mg+, HCO3) (undesired: Na+ Cl- SO4)

Osmotic pressure (cm water, Bar, Pa): inverse pressure to concentration; increase EC->increase osmotic pressure; increase osmotic pressure x-> increase EC (because there are other particles)

*question: can individual ions be estimated from multiple measures of EC and pH? Is EC different in AC high frequency potential field? Local concentration clustering due to external potential field? Will all salts be dissolved in aqueous solution? (ionized?)

Different cultivars have different range of optimal EC. In such optimal range, growth rate decreases and shelflife increases with increasing EC.

Salinity: waterstress; nutrient stress

High EC effects on plant: reduction in growth/yield, higher dry matter content, more firm tissue, blossom end rot (BER)

This comes an effect: SYD (salinity yield decrease) on greenhouse crops: bean = 14.7 (sensitive), spinach=1.2 (insensitive)

Na Cl in water: cucumber and tomato absorb more sodium than sweet pepper; quantities more than crop can absorb will be accumulated. The accumulated amount has a maximum acceptable concentration limit.

pH=acidity of solutions: measure for H+ and OH- concentration high pH may prevent uptaking of Fe and other ions; low pH prevent Mo

high pH may also prevent solubility of compounds/salts

low pH dissolve rockwool; (less than 4, 24 h 60 mL.min-1)

high pH lower CO_2 in air and high HCO_3 in solution

ion uptake balance: between almonia and nitrogen

pH in water: hardiness of water- CO_2: temporary hardiness (boil water CO_2 dispense and pH drop) ; resident hardiness-Ca and Mg; equilibrium between cations and HCO_3

we can remove Ca by HCO_3^- neutralization (1 mmol/l H^+ for each mmol/l HCO_3) (keep +-0.25 mmol/l HCO_3 as buffer due to effect of HNO_3)

irons and calcium need to be removed in order not to precipite/clog irrigation system. But copper need to stay for plant needs.

Salt: sodium chloride (Na Cl), bicarbonate (HCO_3), calcium magnesium, Sulphur (Ca Mg SO_4);

Iron: Mn, B, Zn, Cu, silicon, fluorine F

Nutrient management/ Nutrient management in practice, Nutrient Recommendation Systems, Target values, adjustments

Wim Voogt

EC management and control: drip irrigation, root environment, drainage

EC and nutrients: roughly keeping EC balance: supply + drain= substrate + uptake

EC: supply < uptake < substrate < drain; (use high supply EC to push up uptake EC)

Drain EC is the highest because of forcing high substrate EC to have high uptake, drainage then buildup for the excess

During the entire growing period, high EC at slab and irrigation at beginning and drop gradually towards the final period (if soilless, the final week can increase EC to increase taste.)

EC suggests to be low at summer.

pH management: source water correct scheme: acid quantity->bicarbonate (HCO_3), EC shema->EC irrigation; drip irrigation: pH set point: acid/base dosing 6.3-5 (avoid low pH because some fungus like); fertilizer recipe: ratio adjustment NH_4/NO_3

local pH effect in substrate: pH decrease at high soil and pH increase at low soil because plants absorb ammonia quickly and root absorb nutrients without NH_4. Fungus like low pH.

Nutrients management during crop development reasons

Specific target values for root environment: high specific uptake=avoid over-consumption, risk of antagonistic effects; low specific uptake=risk of shortage/deficiency; EC and pH have interaction

Only cations can be uptake; passive uptake;

Competition among cations: k, Na, NH_4, Ca, Mg

For example, $K_{plant}/Ca_{plant}=K_{medium}/Ca_{medium}$

Closer to the root surface K^+ increase but Na^+ decrease because plant don't need Na^+

Adjusting nutrients: increase one component need to change others in order to balance cations with anions.

Rules for adjustment: determine deviation analysis from standard, adjustments for growing stage, corrections for EC adjustment, correction for water quality, equal settlement of cations/anions for equilibrium of the total ion-sum.

Fertilisation, nutrient solutions and calculations of recipes/Including Spreadsheet for calculation of salt concentrations of nutrient stock solutions

Erik van Os, Wim Voogt /September 2016

Fertilization=fertilizer supply

Nutrient management=supply of plant nutrients to soil or substrate, taking into account: crop, soil/substrate, water quality, interaction between nutrients, specific fertilizer effects, impact on environment

Fertigation: N+P_2O_5+K_2O, CaO, MgO, SO_3 with some percentage (18+18+18+…)

Fertilizers in hydroponics:

Mole: amount of substance in 12 grams of pure carbon; 6.02x10^23 avogadro constant

1 mole of H = 1 gram; 1 mole K = 39.1 gram (6.02x10^23 atoms)

1 gram N = 1/14 = 0.07 mol (molecular weight); 1 gram Mg=1/24.3=0.04mol.

Sum of cations and anions (me: milli-equivalent) should be equal; EC=sum(me+)/10

Substrate: restricted root volume (10-15/m^-2), restricted water and nutrient (2-5% of the total demand)

Fertilizer recipe: put as much Ca(NO3)2 as much as possible; additional NH4+; phosphate source; choose Mg source, choose remaining SO4 as K2SO4; remaining K and NO3 as KNO3

溫室設計方法

Greenhouse Technology/Systematic Design (I) – Reflexive interactive design (RID)/Design framework, steps and methods

Bert van 't Ooster, Thursday 14 September 2016

Factors influence greenhouse design: local climate, market size, resources (fuel, water), soil, land, capital, labor, technology, materials

Agro-ecosystem: ecosystem created by human

Design is about to compromise among stakeholders; think of consequences, design contradictions, wicked links (coupling of wanted and unwanted effects)

Animal husbandry system example: system and actor analysis, structural design, anticipating changes

1. challenge of current system; 2. people involved in the system; 3. objectives and constraint in the design; 3. key actors

1. key function analysis; 2. generate solution;

1. who are willing to pay; 2.

TRIZ (TIPS) (theory of inventive problem solving)

Problem definition: what when why whereof, how, for who is it a problem

Taiwan grower needs: no optimal crop production, too low yield, low degree control, too little protection of crop against: disease, fungi, insects, tropical storms, pricing

Example: greenhouse design: structure, cover type, shade screen, whitewash, thermal screen, heating system. Cooling, CO_2 enrichment -> greenhouse climate model -> crop yield model -> economic model -> feedback through design optimization

Goal: ideal, desired situation: set of key challenge, system boundary, set of requirements

Triz: ideal machines: we need the machine doesn't exist in the domain

Product perfection: never need to be serviced again

Stakeholder typology: power (dormant stakeholder), legitimacy (discretionary), urgency (demanding stakeholder)

Model based design: scenario studies, sensitivity analysis, optimization

Consider design alternatives for accommodating constraints.

Each method: is cost-effective? Cost-benefit analysis, risk assessment

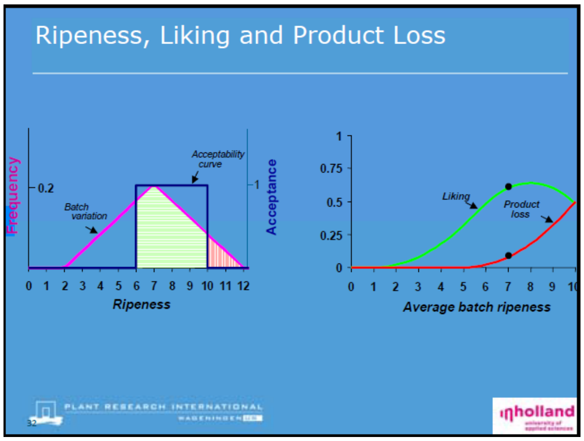
採收後管理

The Market Chain in Horticulture/From soil to mouth

Prof. dr. Olaf van Kooten/9 September 2016

Post-harvest management:

Quality: phenotype = GxExM: genotypes, environment, management (growth rate, stress, harvest maturity, micro nutrients, batch uniformity)



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Postharvest Physiology and Product Quality/ Horticulture and Product Physiology

Julian C. Verdonk

Productivity of a typical greenhouse: 80 kg/m2, water 5 L/kg, pest 5 mg/kg

Quality: intrinsic quality: actual physical product; extrinsic quality: intangible relating; appearance(visual)(size, weight, volume, shape and form; texture (firmness, hardness, softness, crispness, succulence, juiciness, mealiness; flavor (taste and smell)(sweetness, sourness, astringency, bitterness, aroma); nutritional value (carbohydrates, proteins, lipids, vitamins, minerals, fibres); food safety (natural occurring toxins, contaminants, mycotoxins, microbial contamination)

Perishability: food loss > 40%

Plants still living after harvest. Breathing (metabolic process) on entire lifecycle.

Plant respiration: Takes up O2 -> needs it; produces CO2 -> cannot get too high; produces heat -> increase respiration; uses carbohydrates; changes in chemical composition (breakdown cell walls, pectin, membranes use of organic acids, lipids, proteins: reduce quality)

High water content

Banana ripening: ethylene important

Reaction: cut from plant: make stree (separated from leaves, roots, wounding)

Wounding: make apple ripen earlier

Response to mechanical stresses, bruising, damage in handling, sorting, transport

Chilling injury: caused by membrane ruptures due to low temperatures

Ethylene: softening, coloration, taste/flavor production in apple, pear, mango, tomato, banana, melon, avocado… (some flowers are sensitive to ethylene) (ethylene is also involved in de-greening/senescence

Post harvest quality loss: linear or exponential, or logistics kinetics have different time to sell before quality degenerated to an unacceptable quality; starting at quality at harvest (Q_0): genotype, cultivation (environmental conditions, seasonal effect, sugar and taste, cultivation operations, nutrients change crop face life), time of harvest (time of the day, developmental stages)

Postharvest deterioration no distinct in vegetable or fruit organ: from mechanical damage, physiology deterioration, pathology deterioration

溫室設計練習

Seminar - Design of a vegetable greenhouse system for subtropical conditions in Taiwan: a critical discussion

E. Baeza, Bas Speetjens, Silke Hemming/16/9/2016,

Purpose of greenhouse: improve climate to have higher yield; grow crops close to consumers; less water use; less disease; more efficient use of fertilizers (closed irrigation system); protection against heavy rain, wind, snow, insects

Main goal: maximizes profit = crop yield – investments – production costs

To have crop yield: investment (type of cover, heating system, cooling system,, CO_2 enrichment); production costs (fuel, electricity, CO_2, water, labor)

* introduce competition, economies of scales, cooperation, coordination; starting from the determination of crop prices

* link model to sustainability: xxx sharing scheme

* daily radiation and wind speed can be represented by a time-variant distribution -> as a design basis

* apply newsvendor to greenhouse (radiation as demand, competition: xxx, decision: xxx) (the investment of heater?)

Design tool: greenhouse climate model -> yield model -> economic model -> greenhouse optimization algorithm

Greenhouse design covariates: sunlight radiation

Greenhouses usually built close to airports.

Natural ventilation capacity: window fraction m2/m2 (the higher the ratio the more ventilation get) : higher window fraction: less number of hours in warmer than 30 degree but humidity remain the same, evapotranspiration higher, crop yield increases.

Build a greenhouse with completely covered insect net is not wise (yield reduced to 77%)

Concertina insect net (zig-zag) can increase ventilation. (23-30% increase); different net has different discharge coefficient K(epsilon).

Cover: plastic or glass: PC non-thermic not-diffuse get higher potential plant yields

Adiabatic cooling: convert sensible heat to latent heat; fogging capacity (g/m2h) exceeds 300 cannot hardily reduce temperature further.

Pad and fan adiabatic system cannot be applied to long greenhouse.

CO2 enrichment: in Taiwan because strong ventilation, CO2 can hardly retain in the greenhouse.

Screens for light control and energy saving: for Taiwan 30% shading is recommended

Heating demand: solar energy: use heat buffer is enough to provide heat at low radiation days.: use buffer size 200 m3/ha with 0.7 m2 collector/m2 greenhouse ground surface. The payback period is over 10 years.

Closed greenhouses produce great yields but cost is too high.

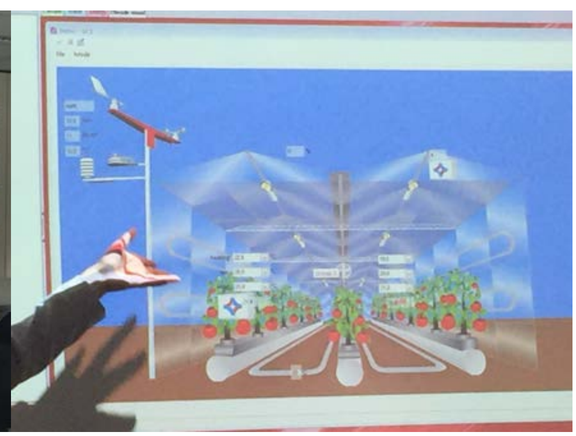
Rainwater storage: from rain precipitation

參訪過程

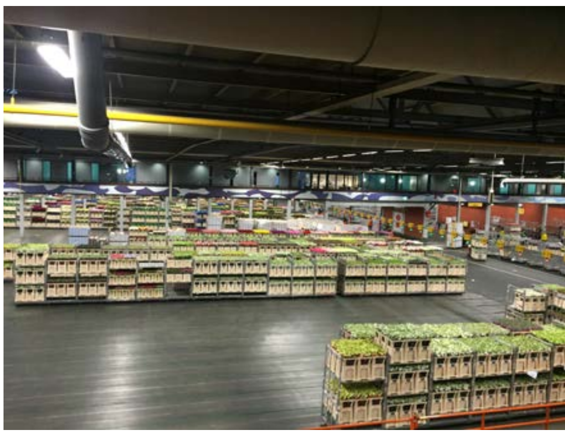
Waterdrinker, Aalsmeer – flower trading

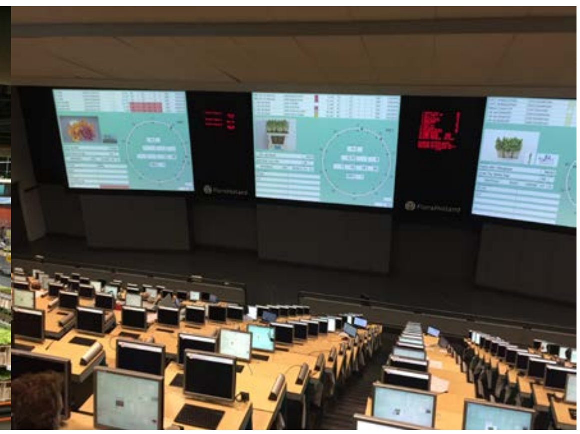
Ridder-Hortimax, Maasdijk – screens, climate computer, fertigation computer, drive systems


Hoogendoorn, Vlaardingen – climate control, sensors incl.

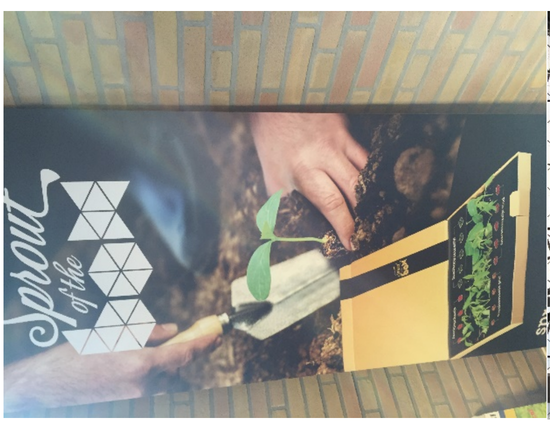
Flora Holland, Naaldwijk – flower auction/ Wematrans, Naaldwijk – logistics

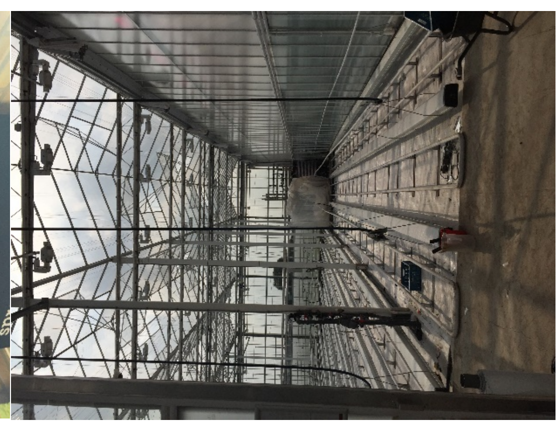




Priva, De Lier – climate and irrigation control

Van der Lugt, Bleiswijk– young plant production

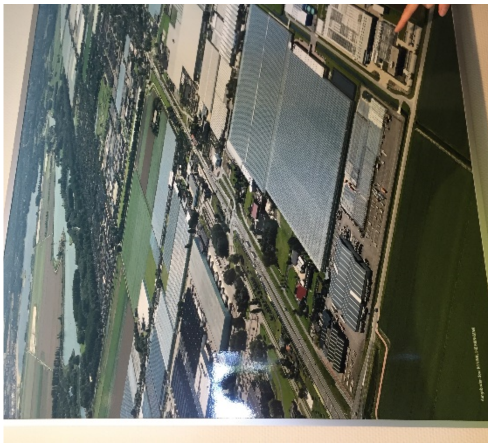




Anthura, Bleiswijk – breeding and young plant production

這張表是本次參訪及研習感觸最深的地方。我們國家的農業技術或是育種技術可能並沒有差先進國家太多，但在管理思維上，我們的農民卻完全跟不上。這張表是顯示這株火鶴種苗，農民買回去之後，如果依照他們的方法種植，在相同的條件下，每個月能夠產出的花朵數。我們農民在生產管理上，基本上還是處於靠天吃飯的心態，投入多少能生產多少，完全處於博奕的狀態。一會生產太多，多到沒人買，一會生產太少，價格高但也買的人有限。怎樣才能導正農民對於農產品有不可規劃的心態，是目前的當務之急。

Wageningen UR Research Station Bleiswijk



3、心得

我們吸收了荷蘭的經驗之後，發現我們在農業技術上並沒有比他們差，但在管理實踐上卻有者不小的差距。如果能以我們在技術上的長處，配合他們在管理上的長處，彌補我們在整合領域的短處，我們一定可以在短期內，改善我們農業的效率，擠身農業強國。

4、建議事項

在學習了三週之後，得到以下幾點建議，可供我們借鏡及努力。

1. Combine weather prediction to climate control: 可以結合氣象預測進行更有效的氣候管理。目前荷蘭已經發展出這種控制方法了，近期內應該就會出現在市面上了。
2. Guide plating by potential yields: 我國的農民在農作物的收穫上，甚少計算每單位面積所能生產出的作物量。在荷蘭，當種苗商賣種苗或種子給農民時，就清楚地告訴農民，這個品種，在今後的每一年的每一個月，在什麼日照及相關的生產條件下，能夠生產多少作物，請參照圖文。在這個課程中，我們所學的課程，讓我們可以得到基礎的生產率，可以提供農民當作調整生產參數的參考。如果最後的收穫只有估計的一半時，至少可以提供一個自我檢討的動機。
3. Introduce information system to crop management: 可以引用基本的資訊系統來管理農產品，從種苗一直到開花結果收穫，都可以有效地最大化農民的利潤。企業資源規劃(ERP)系統，在一般的產業上，使用的非常普遍，希望農業企業化之後，能夠普遍使用這種非常普通的管理軟體。

4. Maintain crop growth model: 雖然日照在台灣似乎並不缺乏，並且為了降溫也做了大量的換氣，但在某些冬日，還是要注意光照、二氧化碳、營養之間的關係，以求植物的最大果實生產量及食用品質。
5. Optimize performance through systematic design: 可以以系統化設計的方法最大化農民在溫室上投資的收益。雖然有著市場價格、天災蟲害等不可預期的風險，如果以荷蘭他們科學化的方法來設計溫室，並做有效的成本收益分析，農民應該會願意投資溫室栽植。
6. Combine plant physiology information to climate control: 可以結合植物生理資訊進行更有效的氣候管理。目前荷蘭商業化產品所發展的控制方法，僅僅控制溫室內日照、光照、溫度、及二氧化碳以達到農民預設的值，而並不是植物當下真正所需要的量。如果能夠以 IoT 的方法，以現有的便宜設備，估計出植物生理數據(例如蒸散率或醣份增加率等)，一定可以對生產的果實的品質有所助益的。目前荷蘭的實驗室正在發展這種技術，而我國的 IoT 及數據計算能力超過荷蘭，是他們所缺少的部份。我們只要結合不同領域的專家學者，一定可以快速超過荷蘭的進度。
7. Supply chain management for post harvesting: 可以結合供應鏈管理，對採收後管理更能極大化農民的收益。在供應鏈方面，荷蘭的研究團隊還正在學習當中。雖然他們在農業物流方面已經有全世界最先進的經驗，但卻少供應鏈整合的概念。台灣在工業化產品上，有著全世界最先進的供應鏈整合及收益整合管理，如果能將工業產品的供應鏈概念，轉化至農產品供應鏈上，我們農民的收益將會得到比荷蘭更多的大幅提升。