PURDUE EXTENSION | LOCAL FACES
COUNTLESS CONNECTIONS

OPPORTUNITIES IN HYDROPONICS

Petrus Langenhoven
Horticulture and Hydroponics Crops Specialist

January 5, 2016

PURDUE UNIVERSITY

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

WHAT IS HYDROPONICS?

DEFINITION OF HYDROPONICS

- **Hydroponics** is a subset of hydroculture and is a method of growing plants using mineral nutrient solutions, in water, without soil.
- The word **hydroponics** technically means working water, stemming from the Latin words "hydro" **meaning** water, and "ponos" **meaning** labor.
- Two types of hydroponics, solution culture and medium culture.
- **Solution culture types** (only solution for roots)
  - **Continuous flow solution culture, Nutrient Film Technique (Dr Alan Cooper, 1960's)**
  - **Aeroponics**
- **Medium culture types** (solid medium for roots, sub- or top irrigated, and in a container)
  - **Ebb and Flow (or flood and drain) sub-irrigation**
  - **Run to waste**
  - Deep water culture, plant contained in a net pot suspended from lid and roots suspended in nutrient solution
  - Passive sub-irrigation, inert porous medium transports water and nutrients by capillary action. Pot sits in shallow solution or on a capillary mat saturated with nutrient solution.

HISTORY

- John Woodward (1699) published his water experiments with spearmint
- Discoveries made in late 19th century resulted in the development of the technique of soilless cultivation.
- 1920's - Dr. W.F. Gericke, University of California. **Developed solution culture technique** pioneered by German scientists Sachs and Knop during 1860-1865. His work inspired further development during the 1930's and '40s.
- Hoagland and Arnon **developed complete hydroponic nutrient solution** in 1938. Revised by Arnon in 1950. Modified several times to include iron chelates. Followed by Steiner (1961) and Cooper (1979).
- During World War II, the U.S. army used hydroponics to grow fresh food for the troops stationed on the infertile Pacific islands.
- Glasshouses in use since 1940's and commercial farms operating by 1950's
- Plastic revolution in 1960's
- Protected cultivation made it possible to control the climate and provide intensive plant care

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

SOLUTION CULTURE

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

NUTRIENT FILM TECHNIQUE , recirculating cultivation system

- Continuous flow of nutrient solution past roots
- Shallow stream (film) of water containing all dissolved nutrients is recirculated past the bare roots of plants in a watertight, dark channel. Roots develop at bottom of channel allowing for an abundant supply of oxygen to the roots.
- Slope of 1:100 recommended, but 1:30 and 1:40 are used
- As general guide the flow rate is 1 L (0.26 gal.) per minute with an upper limit of 2 L (0.53 gal) per minute
- Channel length should not exceed 10-15 meters (33-49 ft.)
- Main advantage: Plant roots are exposed to adequate supplies of water, oxygen and nutrients.
- Disadvantages: Flooding and waterlogging of roots due to design or operation, and dependence on reliable supplies of water and electricity
- Operator have to pay close attention to nutrient balances, water temperature and pathogens

NUTRIENT FILM TECHNIQUE , key system features

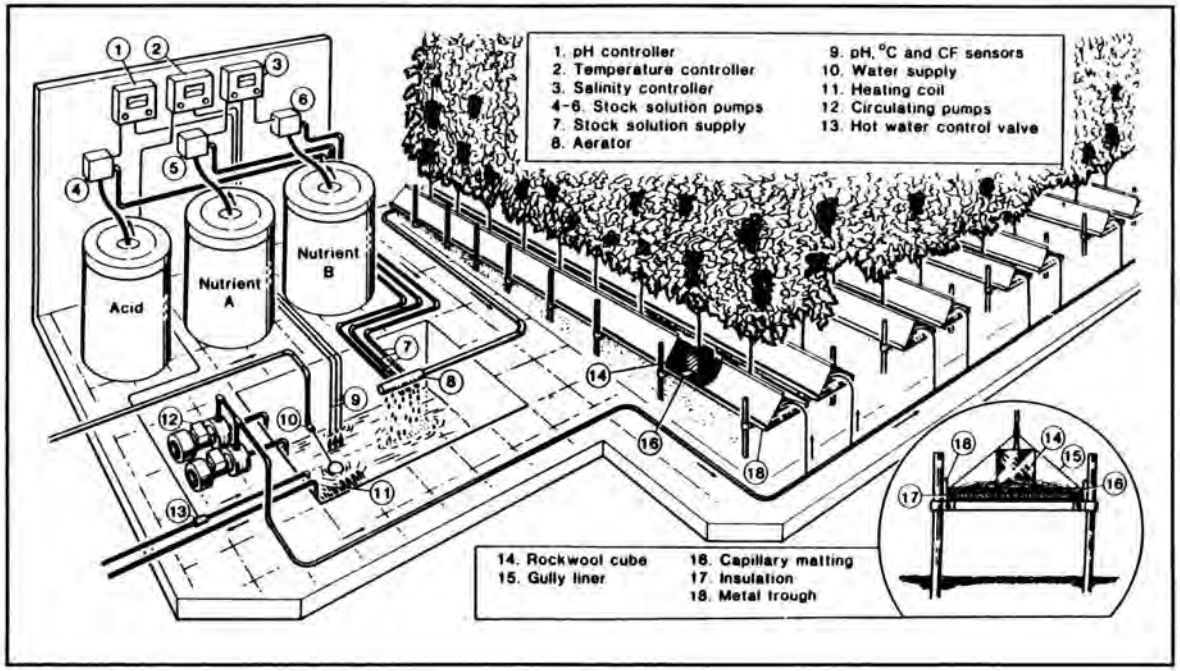


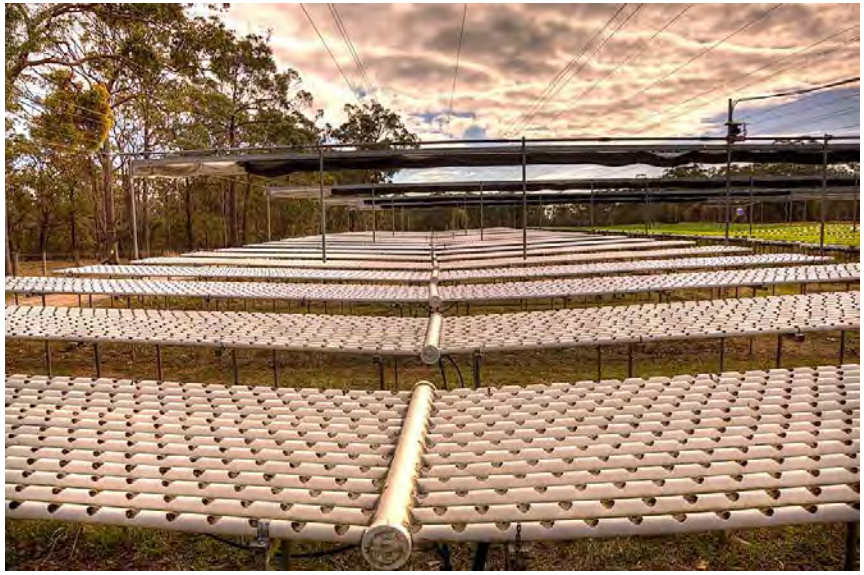
Figure: The Nutrient Film Technique. C.J. Graves, 1983. Horticulture Reviews. The AVI Publishing Company, Inc.

NUTRIENT FILM TECHNIQUE, indoor

Photo: CROP*KING*

Photo: hydrocentre.com.au

NUTRIENT FILM TECHNIQUE, outdoor



Photos: http://www.fancyleaf.com.au/

PURDUE EXTENSION | LOCAL FACES
COUNTLESS CONNECTIONS

NUNTRIENT FILM TECHNIQUE, mobile channel system

Watch video, MGS by Hortiplan

Photos curtesy of Karlovec Media Group
Facility of Great Lakes Growers, Burton, Ohio

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

VARIATION: GRAVEL FLOW TECHNIQUE, home gardener

Photos: Petrus Langenhoven

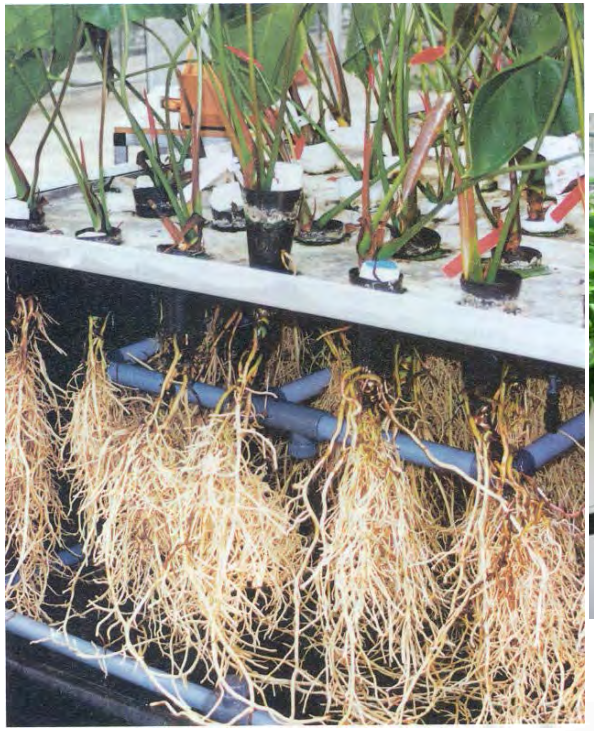
AEROPONICS , recirculating cultivation system

- Roots are continuously or discontinuously kept in an environment saturated with a mist or aerosol of nutrient solution
- Advantages:
  - Excellent aeration, fast plant growth
  - Use 65% less water than hydroponics
  - Receive 100% of the available oxygen
- Disadvantages
  - High cost
  - Dependence on system
  - High level of technical knowledge required
  - Root disease pathogens

Pure Hydroponics Ltd, 2009, www.purehydroponics.com

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

ANTHURIUM FLOWER PRODUCTION



POTATO SEED PRODUCTION

5-10 times more seed than potted systems, International Potato Center (CIP)

Potato Photos: Neiker-Tecnalia
http://www.basqueresearch.com/new/2172

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

MEDIUM CULTURE

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

EBB AND FLOW, recirculating cultivation system

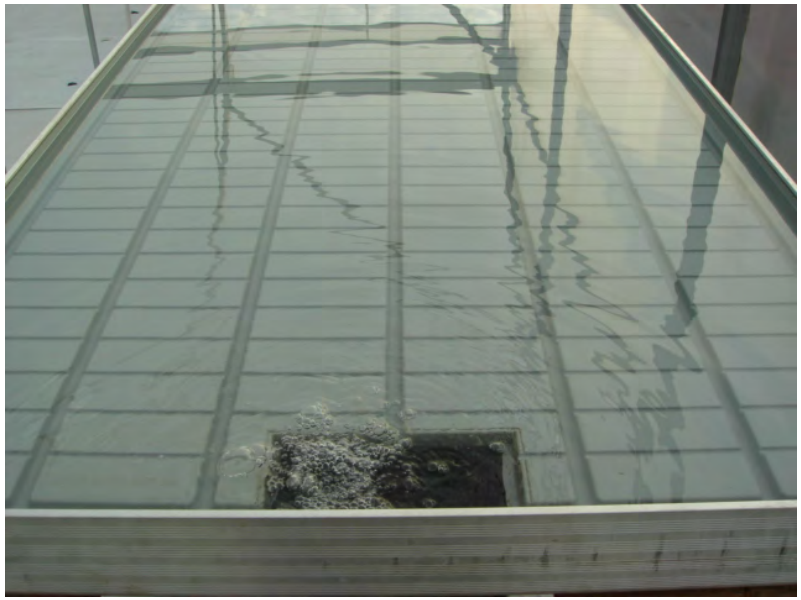


Photo: Petrus Langenhoven

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

EBB AND FLOW, recirculating cultivation system

Photos: Petrus Langenhoven

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

RUN TO WASTE, container with substrate and irrigated individually

Photos: Petrus Langenhoven

PURDUE EXTENSION | LOCAL FACES
COUNTLESS CONNECTIONS

RUN TO WASTE

Photos: Petrus Langenhoven

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

DIFFERENT CONTAINER SHAPES

Photo: Petrus Langenhoven

Photo: Grodan

Photo: ASNAPP. Petrus Langenhoven

Four major factors affect air and water status in containers

-Container, taller containers contain more air

-Substrate, air and water content (porosity)

-Substrate handling, compaction

-Watering practice, water volume and frequency of irrigation

SUBSTRATES

- Most popular substrates
  - Rockwool (Stone wool) (inert)
  - Perlite (inert)
  - Peat moss
  - Coir (Coco peat / Coconut fiber)
  - Vermiculite
  - Rice hulls, sand, soil, clay pebbles, etc.
  - Different substrate mix ratios
- Important factors to consider when deciding which substrate to use
  - Physical and chemical properties
  - Cost
  - Availability
- Different substrate characteristics requires different cultivation practices

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

Very productive system, but.....

9 weeks

13 weeks

Blossom-end rot

Photos: Petrus Langenhoven

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

ENVIRONMENT

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

FROM HIGH TUNNELS TO GLASS GREENHOUSES

Photos: Petrus Langenhoven

Photo: Agricultural Projects Holland B.V.

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

INDOOR VERTICAL FARMS, growing with supplemental light

Photos: Green Sense Farms

GREEN SENSE FARMS
Watch us grow

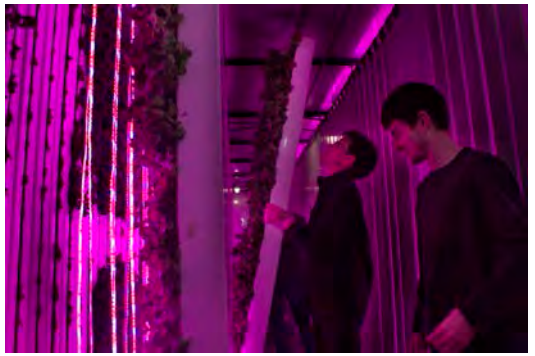


Photo: Freight Farms

Photos: Growtainer

growtainer

Photos: FarmedHere

farmed here
sustainable indoor farming

AQUA PONICS

INNOVATIVE STRUCTURES AND GROWING SYSTEMS:
i.e. CRAVO RETRACTABLE ROOF GREENHOUSE

Photos curtesy of Cravo

Photo: Petrus Langenhoven

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

PRODUCTS

PURDUE EXTENSION | LOCAL FACES
COUNTLESS CONNECTIONS

PRODUCTION OF ALTERNATIVE HIGH VALUE PRODUCTS (example of baby squash). Always conduct a market assessment first!

Photos: Petrus Langenhoven

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

Do things different from your competitors. Be innovative!
TRELLISED MELONS!

Photos: Petrus Langenhoven

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

NOT ONLY CROP BUT PRODUCT DIVERSIFICATION. Culinary Herbs

Photos: Petrus Langenhoven

Photo: Kitchen Pick Living herbs

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

COUNTING THE COSTS

STARTUP COSTS

- Factors affecting costs
  - Location: terrain, climate, distance from suppliers
  - Crop type and growing environment
  - Size and technology
  - Infrastructure for equipment and supplies
  - Infrastructure for postharvest handling and transportation
- i.e. high tunnel (single poly) estimated cost per square ft.
  - 30 x 96 with roll-up sides and gable shutters: $4.21
  - 30 x 72 with roll-up sides and gable shutters: $4.76
  - 30 x 48 with roll-up sides and gable shutters: $5.80
  - 30 x 96 with roll-up sides and ridge vent: $5.29
  - 30 x 72 with roll-up sides and ridge vent: $5.80
  - 30 x 48 with roll-up sides and ridge vent: $6.79
- Aluminum frame with glass or polycarbonate; greenhouse cost per square ft.: $20-30
- Transportation and construction costs are excluded
- Vertical farm: minimum commercially viable unit's capital cost, about $16 million

Figure: RIMOL

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

INFORMATION

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

RELIABLE INFORMATION

- Professional magazines
  - Practical Hydroponics and Greenhouses, www.hydroponics.com.au
  - Greenhouse Grower, www.greenhousegrower.com
  - Greenhouse Canada, www.greenhousecanada.com
- Books
  - Greenhouse Technology and management, Nicolas Castilla
  - Greenhouse Operation and Management, Paul V. Nelson
  - Soilless Culture, Michael Raviv & J. Heinrich Leith
  - Growing Media for Ornamental Plants and Turf, Kevin Handreck & Niel Black
  - Plant Nutrition of Greenhouse Crops, Cees Sonneveld & Wim Voogt
- Trade shows and conferences
  - Indoor Ag Con, April 8-9
  - Cultivate16, July 9-12
  - Great Lakes Fruit, Vegetable and Farm Market EXPO, Dec 6-8
- University resources

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

THANK YOU

Contact details:

Dr Petrus Langenhoven
Horticulture and Hydroponic Crop Specialist
Department of Horticulture and Landscape Architecture
Purdue University
Tel. no. 765-496-7955
Email: plangenh@purdue.edu