

International Conference
LIVING WALLS AND ECOSYSTEM SERVICES
WORKSHOP 4
Living Walls for Vertical Farming
'AQUAPONICS'



University of Greenwich
6-8 July 2015





AQUAPONICS

or

'aquaponics'

A top-down view of a pond with several colorful koi fish swimming in the water. The water is dark and reflects light, creating ripples and highlights on the fish. The fish are in various colors, including orange, white, and black. The text is overlaid on the center of the image.

AQUAPONICS

=

'AQUA'culture

+

Hydro'PONICS'



AQUAPONICS

=

'AQUA'culture

+

Hydro'PONICS'

AQUAPONICS IN DESERT AREAS

**The Future for Combined
Aquaculture and Hydroponics in
Arid Areas**

Dr Benz Kotzen

**School of Architecture and Construction
The University of Greenwich, London**

**The Third International Conference on Drylands, Deserts
and Desertification: *The Route to Restoration*
Ben Gurion University of the Negev
*November 8-11, 2010***

3 Main Types:

1. FLOATING RAFT SYSTEM



3 Main Types:
2. NFT

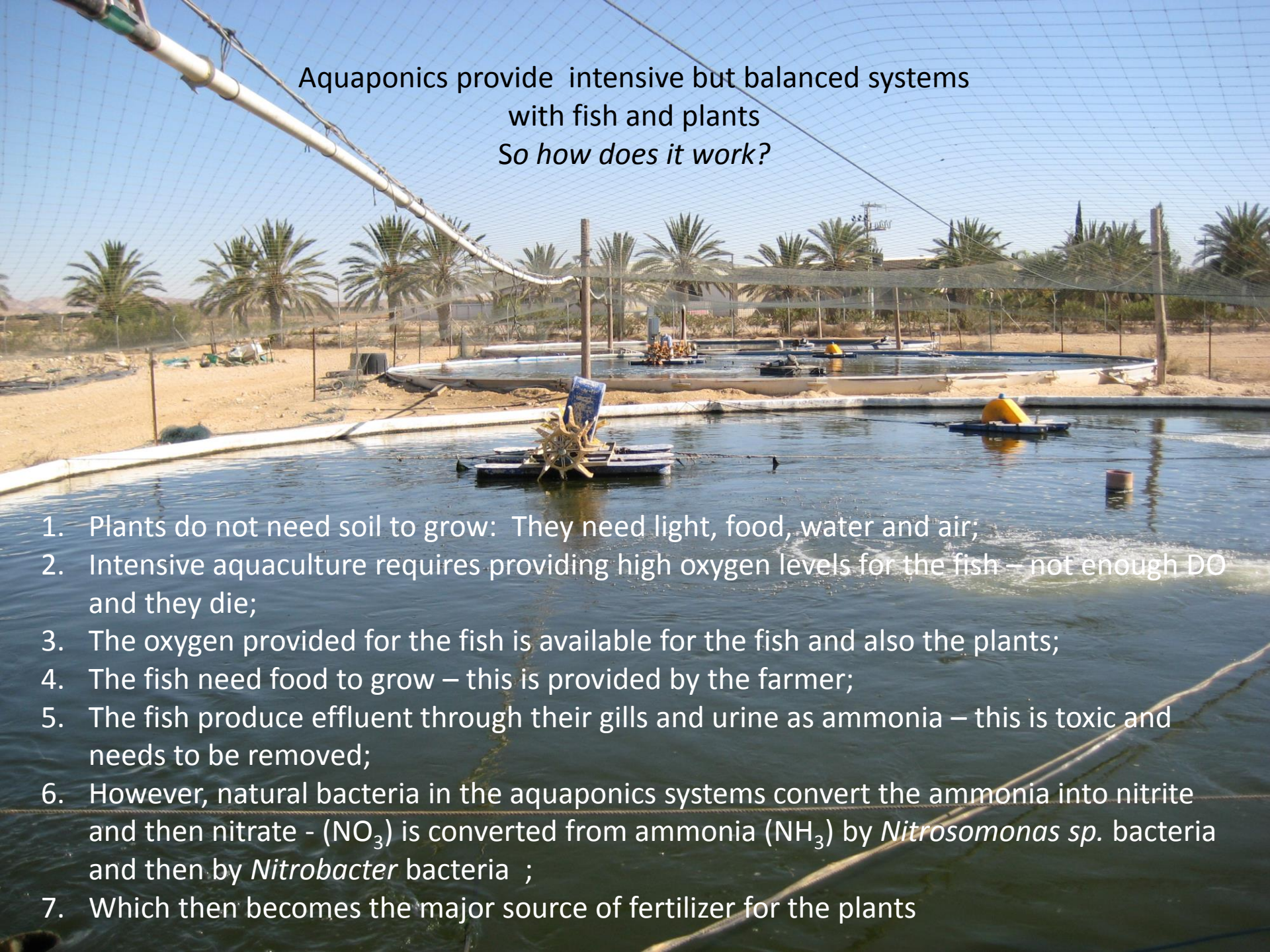


3 Main Types:
3. GRAVEL









Aquaponics provide intensive but balanced systems
with fish and plants
So how does it work?

1. Plants do not need soil to grow: They need light, food, water and air;
2. Intensive aquaculture requires providing high oxygen levels for the fish – not enough DO and they die;
3. The oxygen provided for the fish is available for the fish and also the plants;
4. The fish need food to grow – this is provided by the farmer;
5. The fish produce effluent through their gills and urine as ammonia – this is toxic and needs to be removed;
6. However, natural bacteria in the aquaponics systems convert the ammonia into nitrite and then nitrate - (NO_3) is converted from ammonia (NH_3) by *Nitrosomonas sp.* bacteria and then by *Nitrobacter* bacteria ;
7. Which then becomes the major source of fertilizer for the plants

So what are the main benefits?

There are cost and space advantages:

1. **Less space required – more crops grown in less space;**
2. Aerated water is necessary both for intensive fish production and plant production. The cost of aerating the water for fish production is thus offset by its secondary use;
3. Less use of water for fish as the plants cleanse the water by taking up the fish waste in the form of nitrate (NO_3).
4. Less water is used - Hydroponics is known to use 10% – 20% of the water used in field agriculture where most of the water is lost through percolation into the soil and in hot arid areas through evaporation as well - The water stays in the system and can be reused- thus lowering water costs;
5. Crops grow with minimal inputs as the fish create the fertilizer (nitrate NO_3), which supports plant growth. However: Iron chelate Fe^{+2} as well as other micro-nutrients are usually required. Levels of NO_3^- (nitrate), PO_4^{-2} (phosphate) and SO_4^{-2} (sulfate) are usually sufficient for good plant growth, while levels of K^+ (potassium) and Ca^{+2} (calcium) are generally insufficient. Supplementing K and Ca has a dual purpose of supplementing essential nutrients as well as reducing pH

So what are the additional benefits?

No soil is needed and therefore crops can be grown on alternative sites (e.g. on the roofs of buildings – contaminated sites – but these really need to be flat or increase pumping will be required;

Less growing time required;

Labour and maintenance is reduced;

Nutrients are recycled – costs saved with little nutrition pollution to the environment because of the contained and controlled system;

No weeds and therefore no herbicides and no residues leached into the environment;

Great reductions in pest, and disease problems which can be controlled easier;

Plants grown hydroponically avoids soil borne pests;

More control over the plants rooting environment Easier manipulation of the root zone's temperature, humidity, darkness, etc.);

Higher and more stable yields;

Higher quality products – if using organic feed = organic fish and plants;

Potentially extended growing season;

Pests and diseases are easier to get rid of than in soil because of growing in containers and the container's mobility.

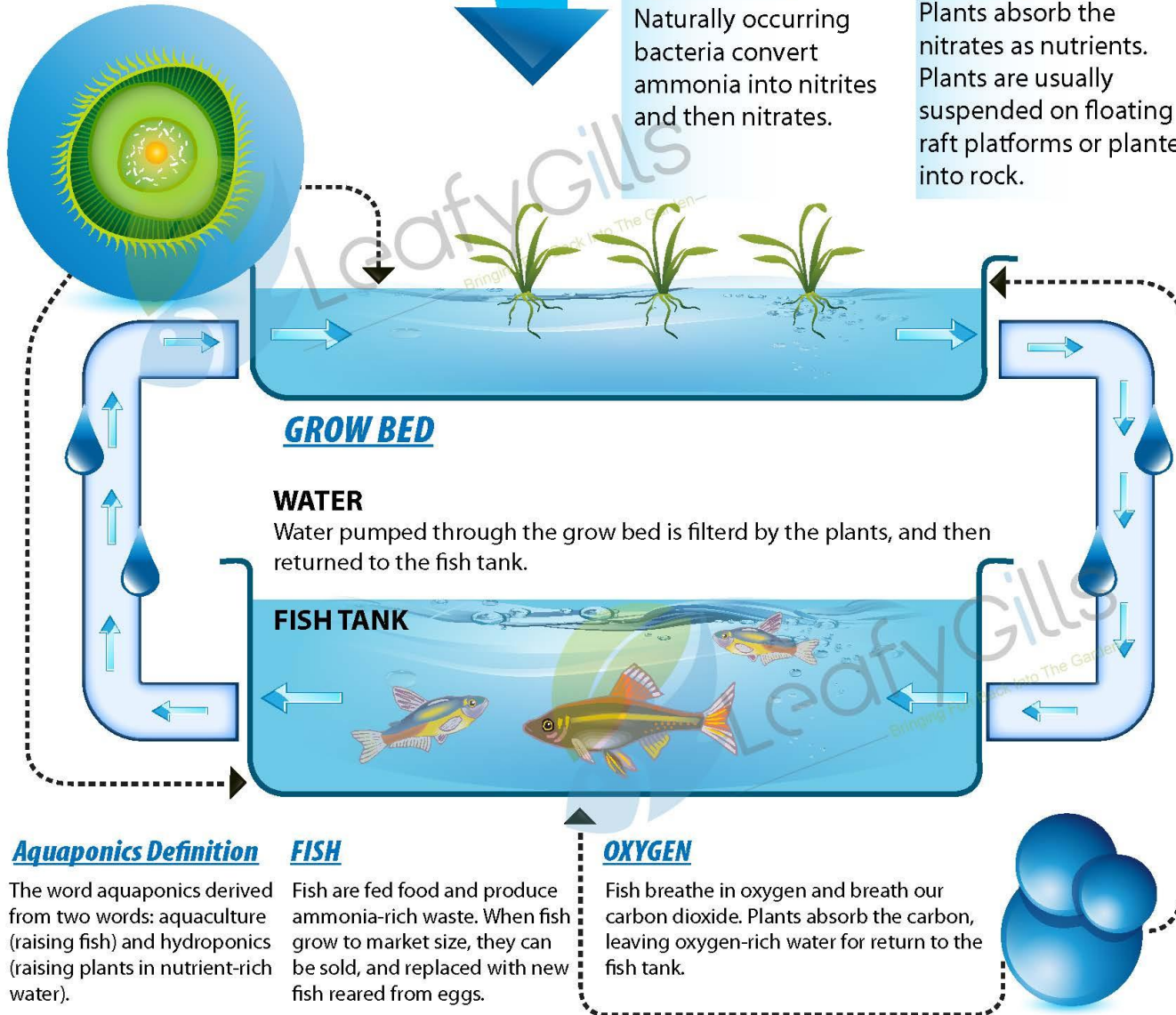
HOW AQUAPONICS WORKS

BACTERIA

Naturally occurring bacteria convert ammonia into nitrites and then nitrates.

PLANTS

Plants absorb the nitrates as nutrients. Plants are usually suspended on floating raft platforms or planted into rock.





Products: UrbanFarmers grows high-margin, fresh produce specialties and fish

Currently produced specialties



Microgreens (e.g. moustarde)



Tomatoes (e.g. Zebrino)



Herbs (e.g. red basil)



Sweet water fish (e.g. tilapia)



Salads (e.g. Decartes)



Strawberries

Also possible now*



Bell peppers



Tea plants



Cucumbers

Possible in future*



Sweet water prawns



Mangos



** list not exhaustive*



Pentair Green Sky Growers



Pentair - Green Sky Growers

COST Action 1305

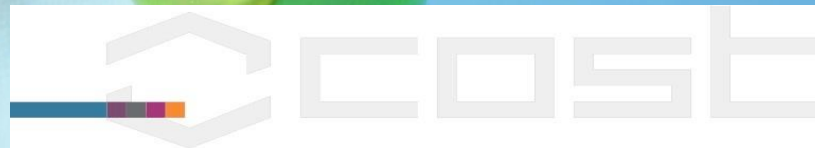
The EU Aquaponics Hub: Realising Sustainable Integrated Fish and Vegetable Production for the EU

THE 3 BIG WHATS + WHYS

WHAT + WHY?

WHAT + WHY?

WHAT + WHY?

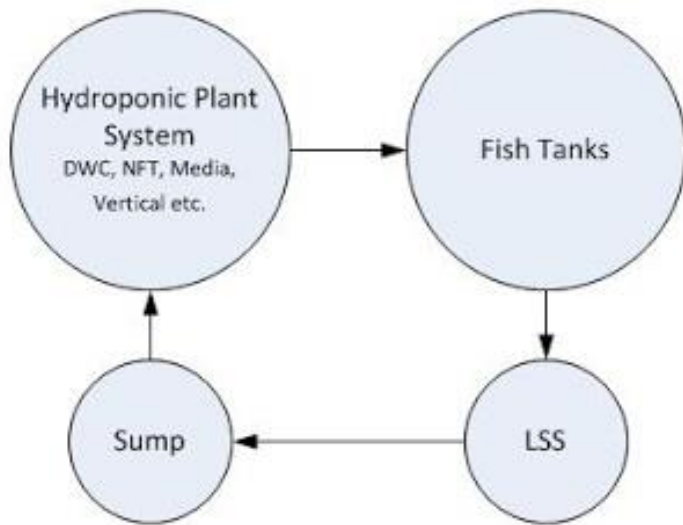


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of
GREENWICH

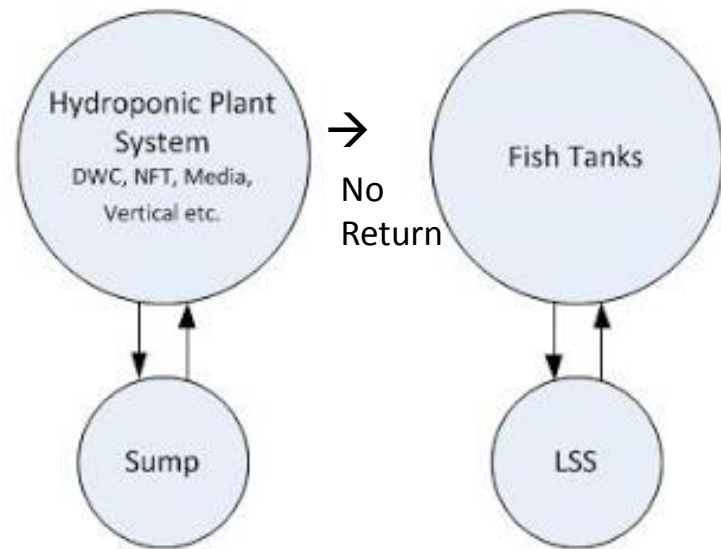
The EU Aquaponics Hub focuses on 3 primary systems in 3 settings;

- 1) 'Industrial scale aquaponics';
 - 2) 'Cities and urban areas' - urban agriculture aquaponics,
 - 3) 'Developing country systems' - devising systems and technologies for food security for local people
- providing competitive systems delivering cost effective, healthy and sustainable local food in the EU.

Fish and plant system coupled



Fish and plant system de-coupled

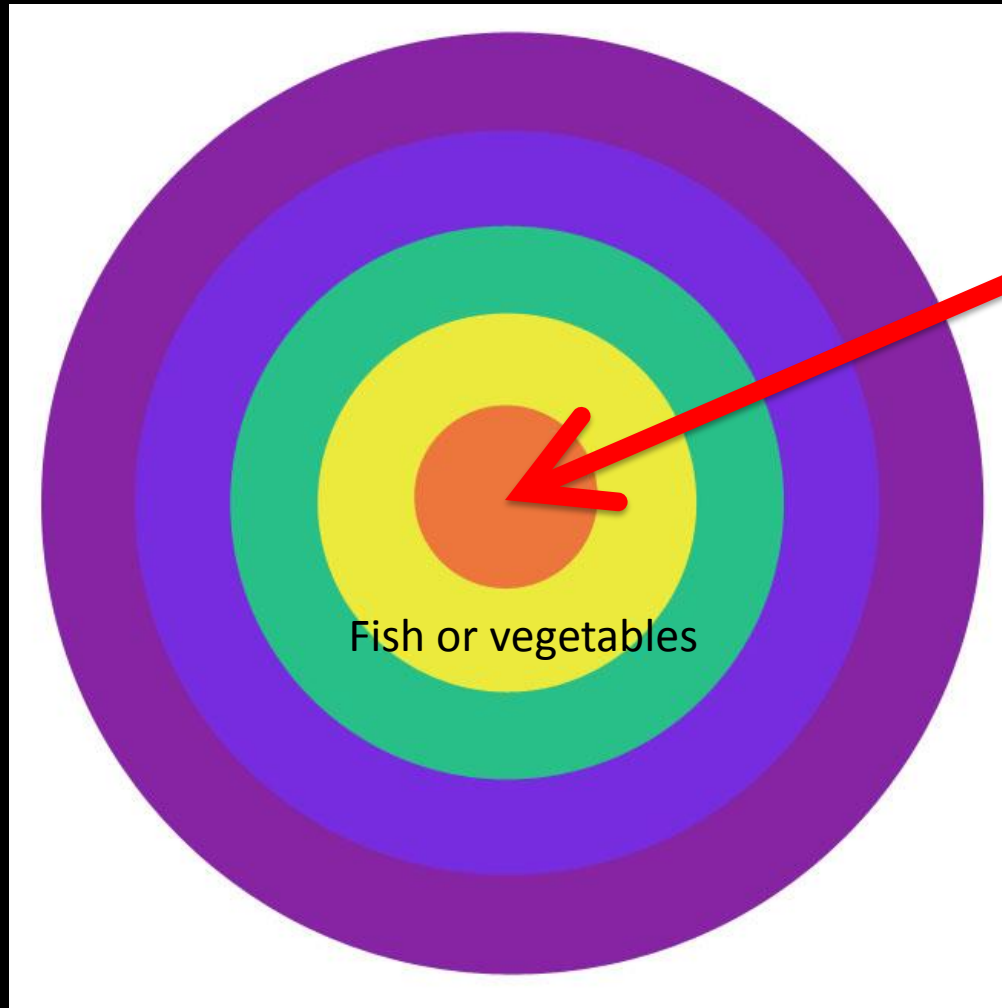


LSS – Life support system = filtration

What produce is more important, fish or plants?

<http://www.coloradoaquaponics.com/announcements/aquaponicsystemdecoupling>

What is the target product?





Thanet Earth, Kent, UK – 7ha green house



Thanet Earth, Kent, UK



Large RAS - Recirculating Aquaculture System



AECOM – Futurist Conceptual City Space



AECOM – Futurist Aquaponics

2. AQUAPONICS AS PART OF URBAN AGRICULTURE

The Stockwell Street Multi Objective Environmental Roof











Austin Urban Solutions & Rosner
Studio Aquaponics Container System

Michael Jantzen – Eco-Aquaponics House



URBAN FARMERS

GOOD FOOD, FROM THE ROOF



THE GLOBE

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UF001 LokDepot: the world's first Aquaponic rooftop farm with commercial purpose

Foto: by Raphi See




Key figures:

- 260 m² of production space, Construction budget CHF 800k
- Construction finished Oct 2012, going live in Q4 2012
- Capacity of producing annually 5'000 kg vegetables & 800 kg fish

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Kommission für Technologie und Innovation KTI

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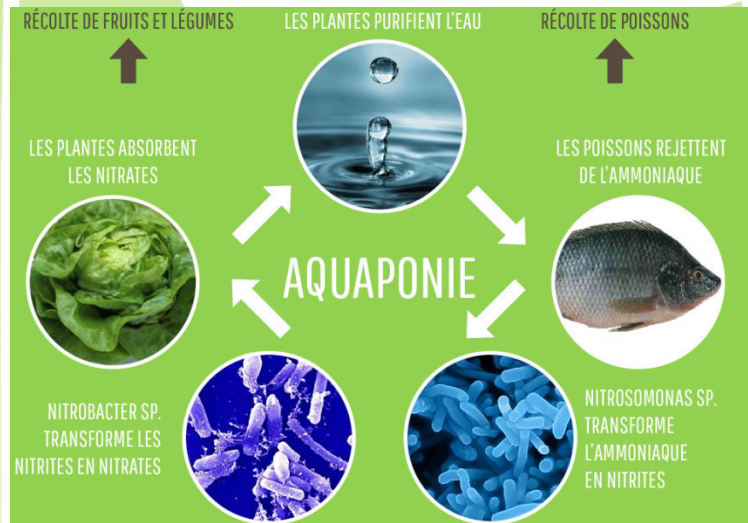
GYSI BERGLAS AG

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 **NATIONAL
INSTRUMENTS™**

UrbanFarmers.com

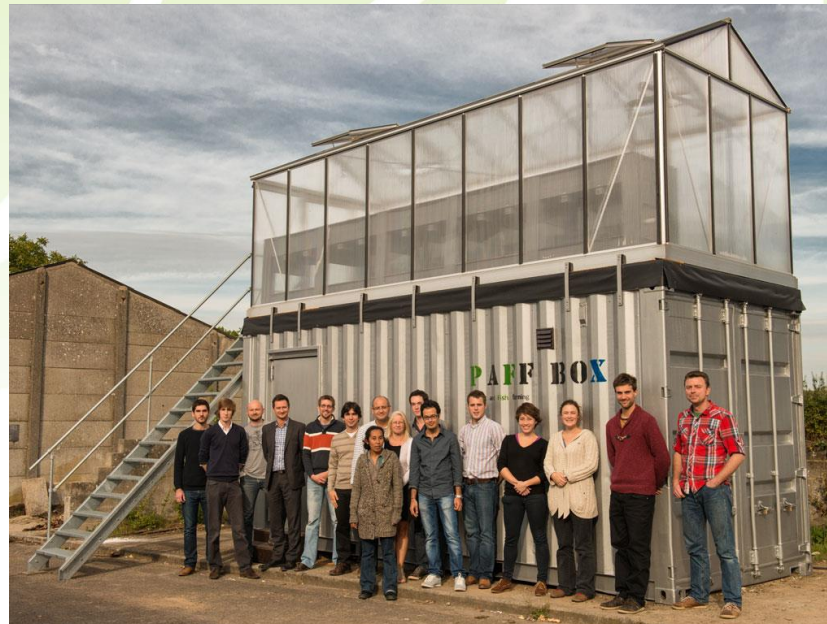




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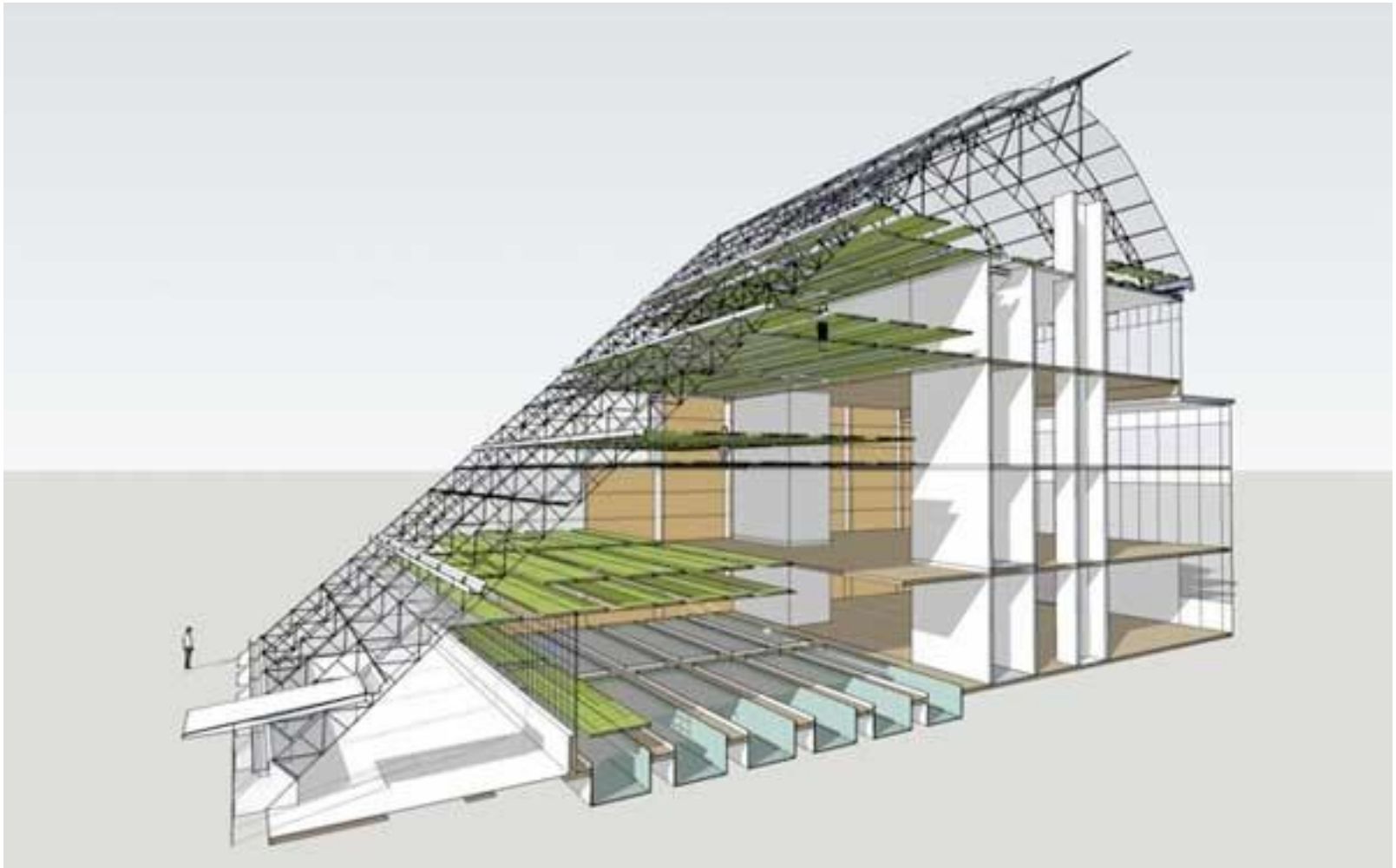
Haïssam Jijakli

mh.jijakli@ulg.ac.be





Grow Up launched at the Chelsea Fringe



Will Allen – ‘Growing Power – 5 storey expansion of Milwaukee Headquarters



Pegasusagriculture.com



Greeningforward.com



Hydroponic Pumping
Station
By: mod:lina



**Imagine producing in a 50' x 75' area
as much food as a 16 acre farm.**

**Introducing VertiCrop™, a proprietary growing method selected in
2009 by TIME Magazine as one of the World's Greatest Inventions.**

This patent pending technology was developed to grow food naturally in bustling urban environments and represents a paradigm shift in farming and food production. Providing up to 20 times the yield of normal field crops, while using only 8% of the water typically required for soil farming.

Utilizing a unique, suspended tray configuration on a moving conveyor system, VertiCrop™ provides optimal exposure to either natural or artificial light along with precisely measured nutrients for each plant. Designed to grow healthy, leafy green vegetables in closed loop and controlled environments, VertiCrop™ eliminates the need for harmful herbicides and pesticides, while maximizing taste, nutrition and food value.





Verticrop

An underwater scene with a school of silver fish swimming in clear blue water. In the foreground, several pieces of fresh produce, including a red tomato, a green bell pepper, and a yellow bell pepper, are visible, appearing to be part of the aquatic environment. The text is overlaid on this scene.

The next focus in
Architecture is

'biophilia'

integrating nature

into architecture

Including food production





TR Hamzah & Ken Yeang
EDITT Tower (“Ecological Design
In The Tropics”)



Bosco Verticale- Milano – Stefano Boeri Architects



Bosco Verticale- Milano



photo_credits_Barreca&LaVarra

Bosco Verticale- Milano

Bosco Verticale- Milano



Biophilic Cities | Beatley,
Timothy. (2011).
*Biophilic Cities:
Integrating nature into
urban design and
planning*. Washington,
DC: Island Press.



















Das Algenhaus, Hamburg



500.000 species of algae, but only around 10 of them are researched and industrially used. Fritz Cotta developed special reactors that look like fir trees. With this method, they can produce 130 kg biomass in 200 days.



3. AQUAPONICS IN THE DEVELOPING WORLD

- Providing local nutrition in



Somerville, C., Cohen, M.,
Pantanella, E., Stankus, A. &
Lovatelli, 2014. *Small-scale
aquaponic food production.
Integrated fish and plant
farming*, FAO Fisheries and
Aquaculture Technical Paper No.
589. Rome, FAO. 262 pp

Small-scale aquaponic food production

Integrated fish and plant farming



Finder

 <p>How Michael McIntyre was told</p>	 <p>Anni said 'wedding was a sham and</p>	 <p>A Labour MP will be next to join UKIP,</p>	 <p>Top Gear used Falklands-row plate</p>	 <p>Baby avocados 'essential'? Only at</p>	 <p>'Is Bruce dead yet?' Comedian Jim</p>	 <p>Hitler 'had s</p>
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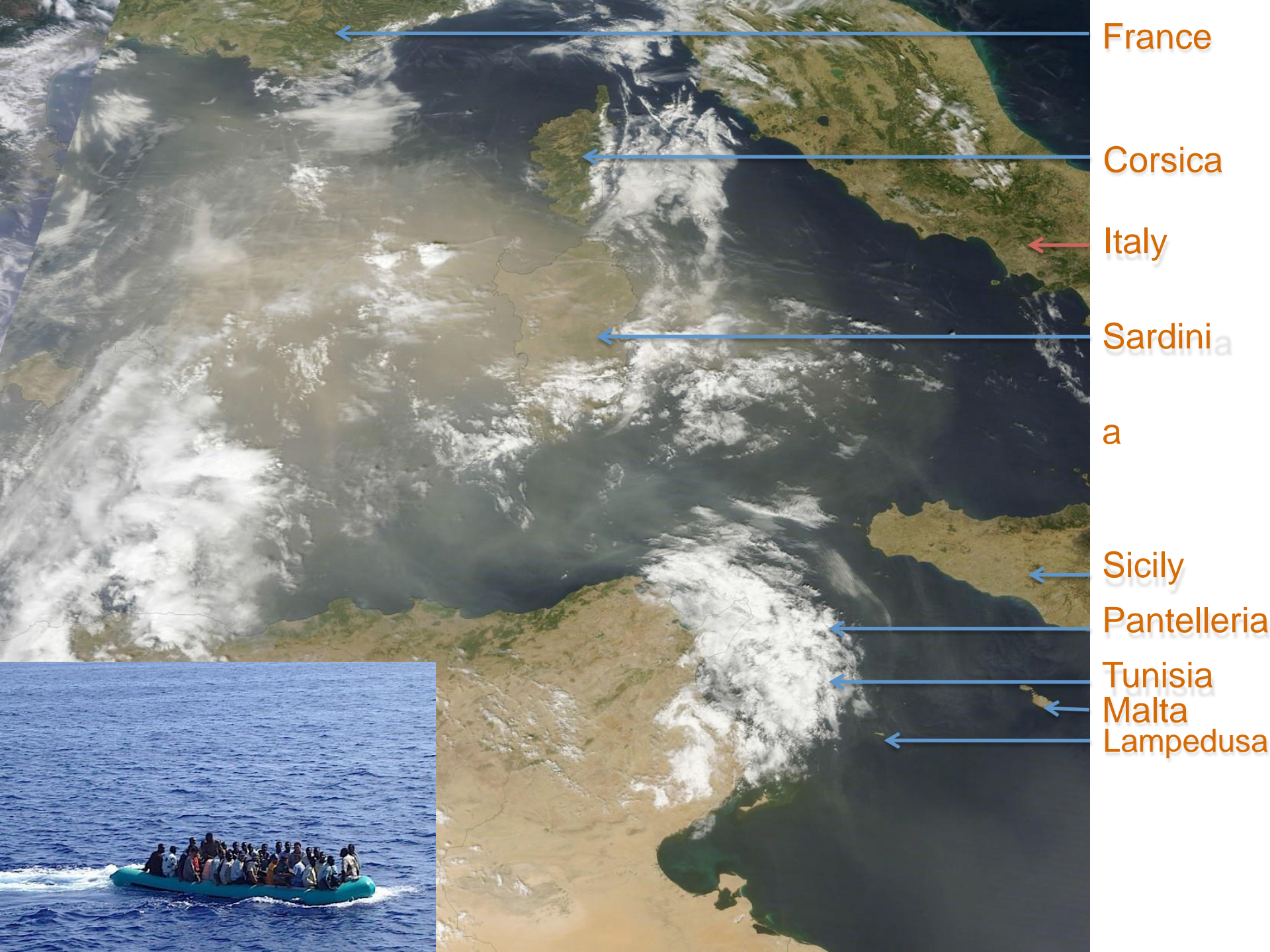
600,000 migrants are lined up along North African coast and ready to enter Europe this summer warns Italy

- Several hundred thousand migrants set to enter Europe, Italy warns
- 'Up to 600,000 ready to set sail' from North Africa this summer
- Of the 40,000 who crossed into Europe last year, 20 per cent came to UK

Site Web



THIS IS THE BIG WHY



France

Corsica

Italy

Sardinia

a

Sicily

Pantelleria

Tunisia

Malta

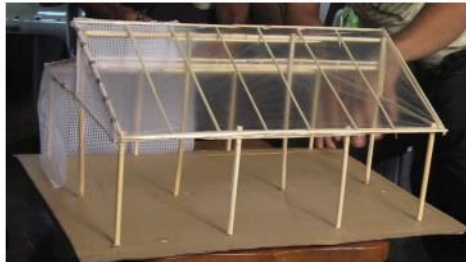
Lampedusa

Managing drought for more profitable livelihoods



ANNEX III

Comparison between bamboo vs traditional greenhouses



Bamboo greenhouse
Cost (full inclusive): 7-10\$/m²



Traditional greenhouse for tropics
Cost: 50\$/ m²

**Redditivity from lettuce @ 20 plant/m² : 4\$/m² in 4 weeks
(0.2\$/head of net profit)**

Return on investment approx 2
months

Return on investment approx
12.5 months



Particular of the bamboo greenhouse prototype in Yangon University.
Design and project planning: by Eddie Pantanella, PhD

EU Aquaponics Hub: Realising Sustainable Integrated Fish and Vegetable Production for the EU

The EU Aquaponics Hub is a four year COST (Cooperation in Science and Technology) networking Action that unites a heterogenous group of scientists, researchers and SMEs from across the EU and around the globe to better understand the state of knowledge in aquaponics in Europe and around the world and to facilitate innovation and education in this field of sustainable fish and vegetal food production.

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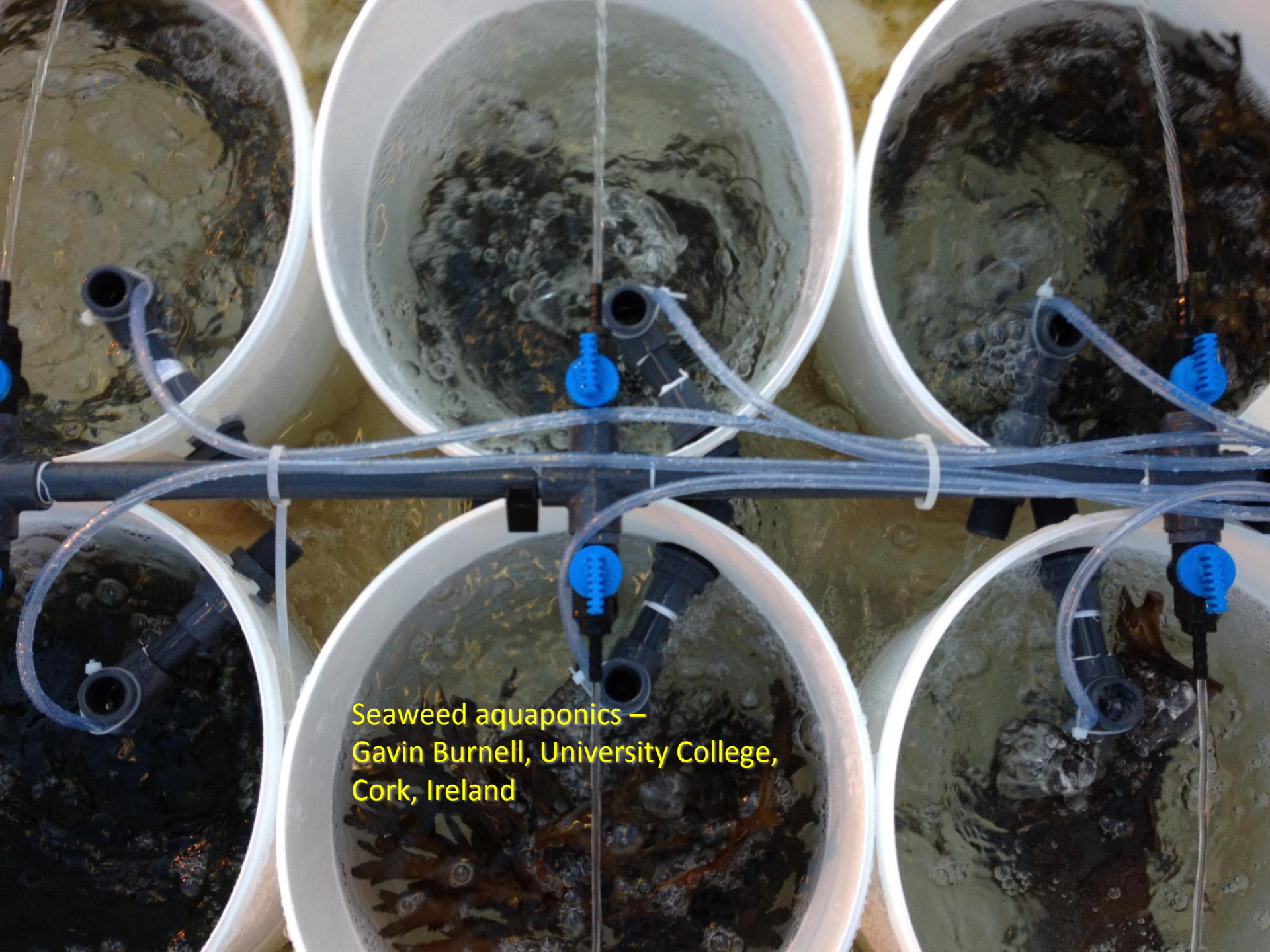
COST Action FA1305

COST Action FA1305, 'The EU Aquaponics Hub' is a timely intervention which responds to the growth in aquaponics research and development in the EU and around the world.

<https://euaquaponicshub.wordpress.com/wp-admin/customize.php>



Marsh samphire - Gavin Burnell, University College, Cork, Ireland



Seaweed aquaponics –
Gavin Burnell, University College,
Cork, Ireland



Adaptive Production – ‘the new pick your own’

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