

UK Sustainable King Prawn Project

Land-Based Seafood



TUKFS26 Conference
Mon 23rd Mar 2026



Prof. Rod Wilson (r.w.wilson@exeter.ac.uk)

Prof. Ian Bateman, Dr. Yiorgos Gadanakis, Dr. Rob Ellis, Dr. Alexis Perry,
Dr. Mike Allen, Prof. Nick Smirnoff, Prof. Angus Buckling, Dr. Pawel
Sierocinski, Dr. Martin Blackwell, Dr. Robert Dunn, Dr. Bill Russell
Dr. Diana Tingley, Dr Jorge Campos-González, Dr Thiago Morello,
Dr. Trystan Sanders, Dr. Owaen Guppy, Dr. Rajesh Manchi

Project Partners:

Renewable Energy



Seafood Retailers & Suppliers

Sainsbury's

LYONS SEAFOODS



Aquaculture/Nutrition



Cargill



THREE-SIXTY



AQUACULTURE

Wider Sector Partners



PML Applications Ltd



University
of Exeter



University
of Reading



ROTHAMSTED
RESEARCH



Biotechnology and
Biological Sciences
Research Council



TRANSFORMING
UK FOOD
SYSTEMS
Strategic Priorities Fund



Rob Ellis



Trystan Sanders



Kat Clayton



Alexis Perry



Owaen Guppy



Nick Smirnoff



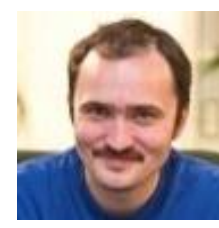
Mike Allen



Rajesh Manchi



Angus Buckling



Pawel Sierocinski



Ian Bateman
OBE



Thiago Morello



Bill Russell



Yiorgos Gadanakis



Jorge Campos-González



Robert Dunn



Martin Blackwell



Andrew Whiston
(CTO RASTECH)



Diana Tingley
(Proj. Man. & Bus. Fellow)



Mattia Mancini



Phil Laws



Daphne White



Martha Clarke



University of Exeter



University of Reading



ROTHAMSTED RESEARCH


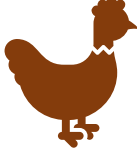

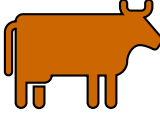
Wide Range of Expertise:

- Physiology
- Chemistry
- Microbiology
- Crop Science
- Aquaculture
- Biochemistry
- Agric. Economics
- Environ. Economics
- Innovation & Entrepreneurship

King Prawn RAS Farm Demonstrator



Aquatic Animal Protein – Healthier AND More Efficient than Terrestrial

				
Edible Meat (per 100 kg Feed)	56 kg	39 kg	19 kg	7 kg
Carbon Footprint (kg CO ₂ /kg Edible Meat)	5.1 kg	8.4 kg	12.2 kg	39.0 kg
Water Consumption (Litre/kg Edible Meat)	2,000	4,300	6,000	15,400

AND Land Use Efficiency...



UK Sustainable King Prawn Project



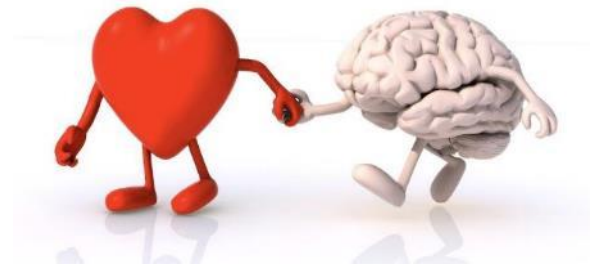
Popular, healthy seafood in UK:

High in protein, vitamins, minerals & antioxidants

Low fat & calories

Promoting brain and heart health

£319M p.a UK imports



University
of Exeter



University of
Reading



ROTHAMSTED
RESEARCH



TRANSFORMING
UK FOOD
SYSTEMS
Strategic Priorities Fund



Biotechnology and
Biological Sciences
Research Council

Traditional Prawn Ponds



Rod Wilson & Rob Ellis visiting prawn farms in Thailand



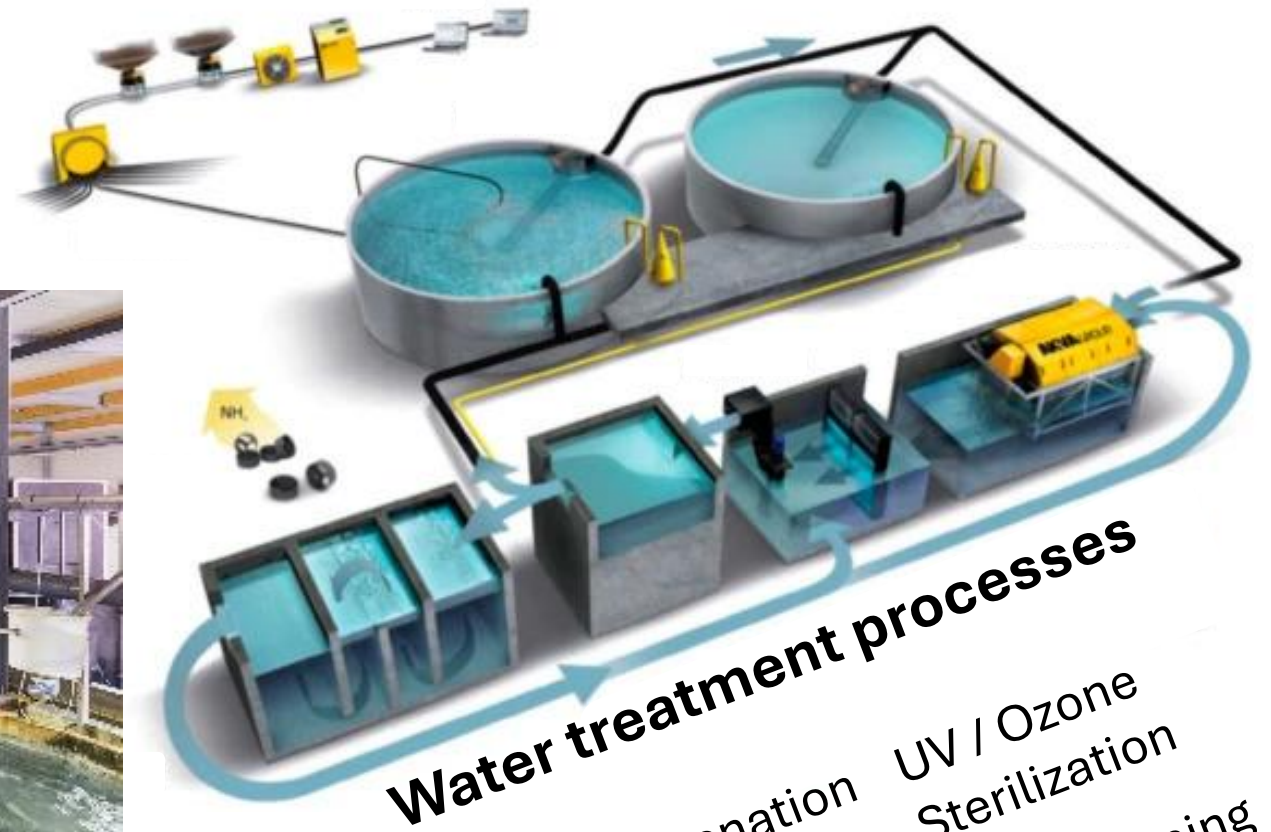
Coastal Mangrove Forest



Removing Mangrove = Removing Benefits:

- Best CO₂ removal ecosystem (per hectare)
- Nursery habitat for 10,000's of marine species
- Coastal Protection (storms & farmland salination)

Another Way ... Indoor Recirculating Aquaculture Systems (RAS)

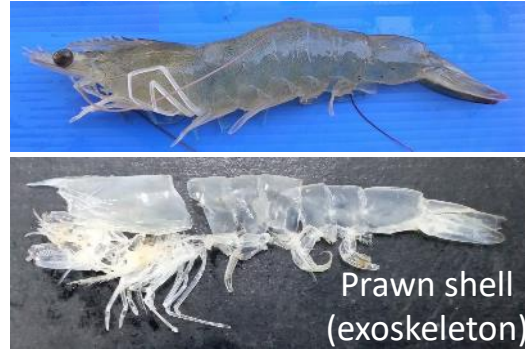
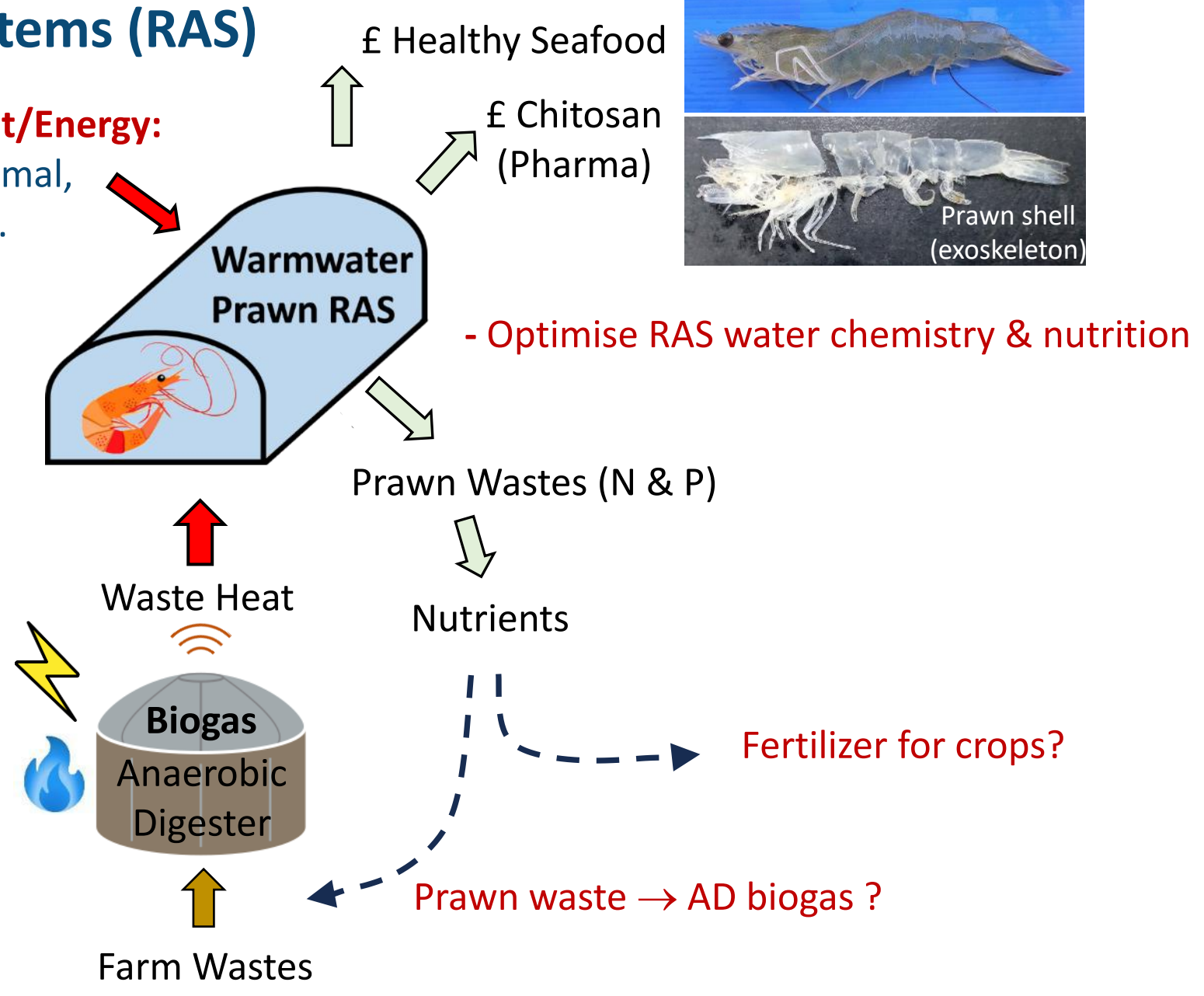


Water treatment processes

- Mechanical Filtration
- Biofiltration
- Oxygenation
- Chemistry Control
- UV / Ozone Sterilization
- CO₂-Stripping

Recirculating Aquaculture Systems (RAS)

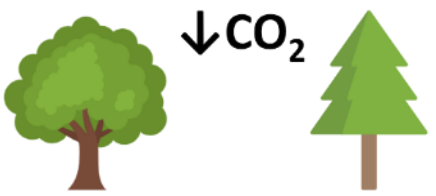
Other Renewable Heat/Energy:
Data Centres, Geothermal,
Solar, Wind, Hydro etc.



Recirculating Aquaculture Systems (RAS)

“Public Money for Public Goods”
(Nature Positive Food Systems)

Net-Zero Emissions



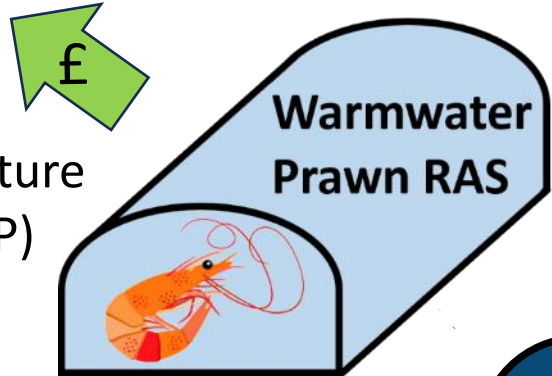
Biodiversity



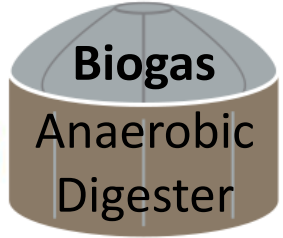
Flood Risk



New Agriculture Act (25YEP)



Waste Heat



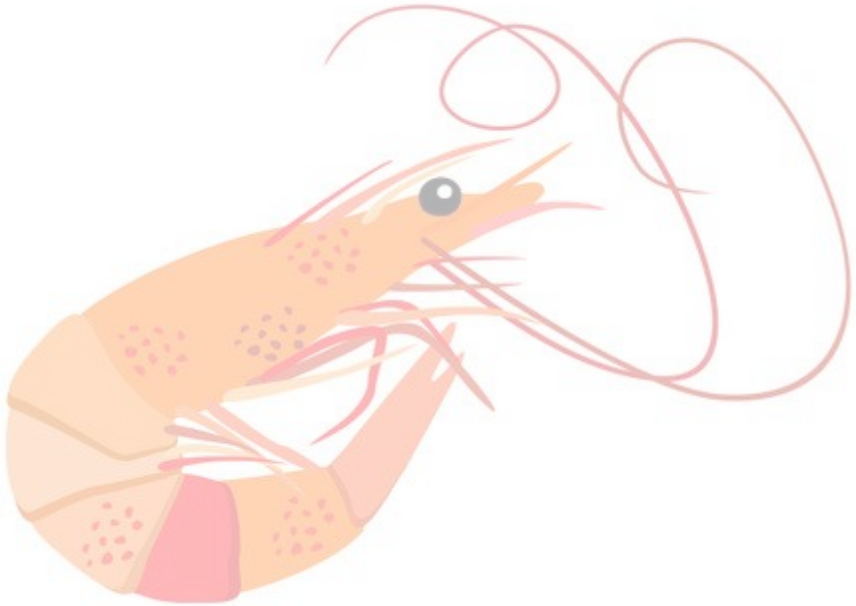
Farm Wastes

“RAS-RES”
Recirculating Aquaculture Systems
powered by
Renewable Energy Systems

= land-efficient, low-carbon
alternative to seafood imports

Moulting – the “bottleneck” in a crustacean’s life cycle (>50 x !)

Water



**Moulted (shed)
old exoskeleton**



Trystan
Sanders



Kat
Clayton

Moulting – the “bottleneck” in a crustacean’s life cycle (>50 x !)

Calcium

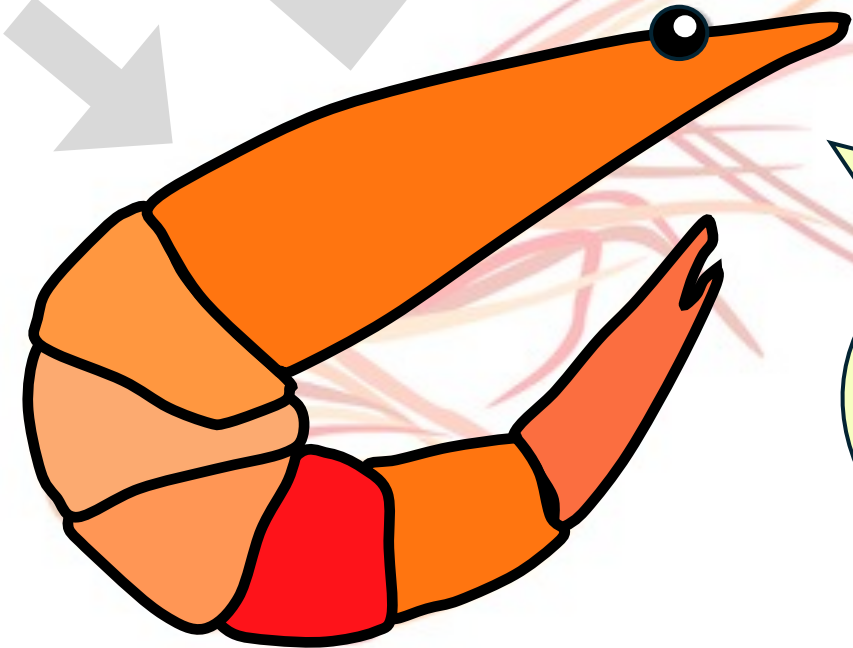
Bicarbonate



Trystan Sanders

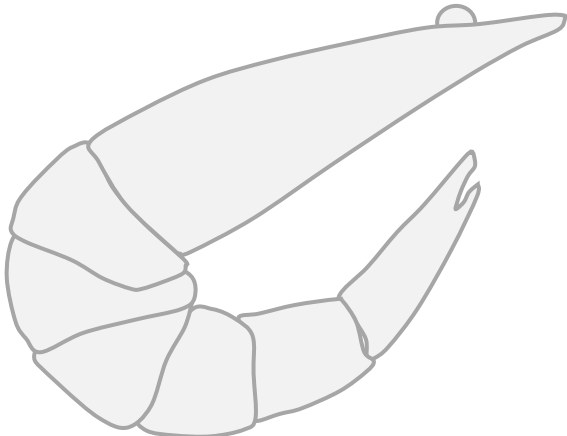


Kat Clayton

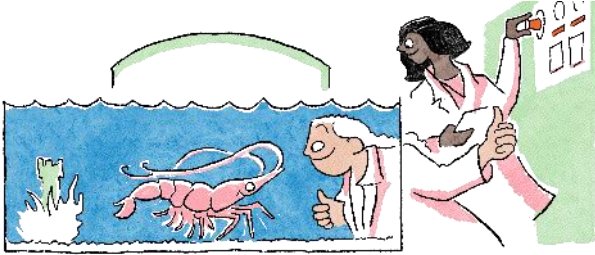


Fastest calcium uptake **ever recorded**
≡ growing all your bones overnight!

Fully calcified (hardened) new shell



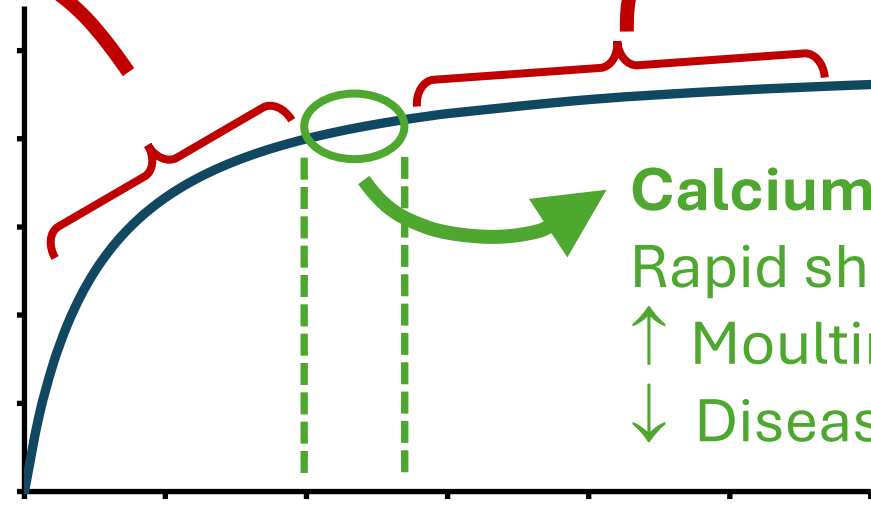
Optimising Water Chemistry for Moulting & Growth (AND... Resilience & Profit)



Too Little Calcium :
Slow Hardening
= Soft Shells

- ↑ Cannibalism;
- ↑ Disease
- ↓ Tolerance to Change

Calcium Uptake Rate



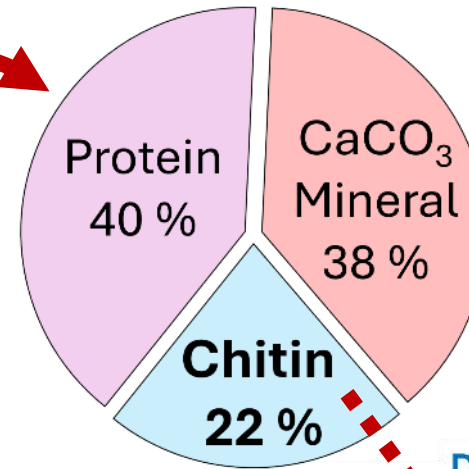
Water Calcium Concentration

Too Much Calcium :
↑ Costs (but no benefits)
Toxicity to animals
Limescale accumulation
on pumps/pipes

Calcium Sweet Spot:
Rapid shell hardening
↑ Moulting success, Growth and Yield
↓ Disease Risk

Also - water salinity, CO₂, nitrate
- dietary vitamins

Maintaining chitin yield for extra income



Salinity – how low can we go?

Prawn growth & chitin yield good down to 4 % of seawater (1.4 ppt – almost freshwater)

i.e. Can build prawn RAS anywhere inland
(BUT only if calcium well managed)



Sanders et al. (2025). *J. Exp. Biol.* 228, jeb249906.

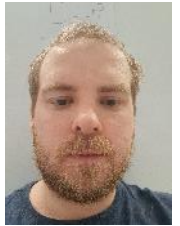
Sanders et al. (2025) *Aquaculture* (Accepted)

Managing Calcium is Key

Real-time Ca^{2+} sensor needed

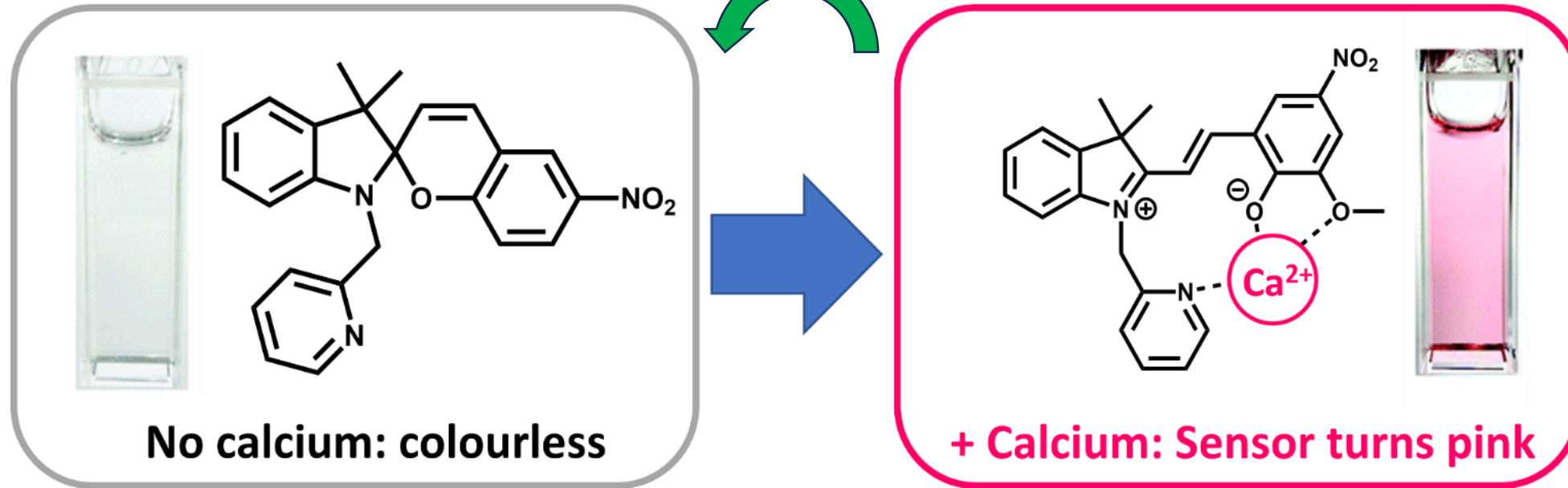


Alexis Perry



Owaen Guppy

Light (Reverses Ca^{2+} -Binding)

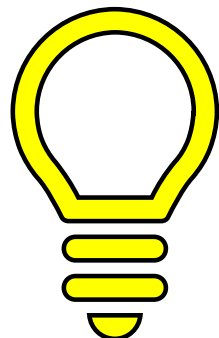


Commercial Device Solution:

Polymer-bound, re-usable colorimetric sensor

Turning calcium sensor molecule into commercial device

UK Patent Filed 03/02/26: "Calcium Sensor" Application No. 2602434.9



UK Sustainable
King Prawn
Project
(BBSRC, £2.5M)



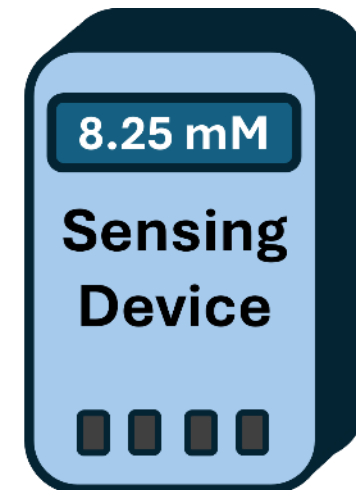
Business
Engagement &
Innovation Award
(UoE, £11.9k)



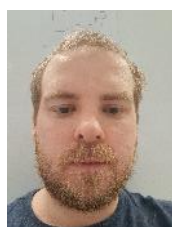
Impact
Accelerator
Award
(EPSRC £68k)



Follow-on Fund
(BBSRC £600k)



Alexis
Perry



Owaen
Guppy



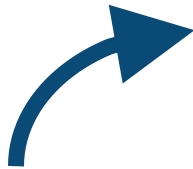
Matt Stevenson
(CEO at Seneye Sensors Ltd., Norwich)



seneye

Academic research chemistry + industrial expertise = innovative solution to real-world problem

Circularity of Prawn RAS Wastes



Robert
Dunn



Martin
Blackwell



ROTHAMSTED
RESEARCH

Prawn waste successfully used as soil enhancer for growing rye grass

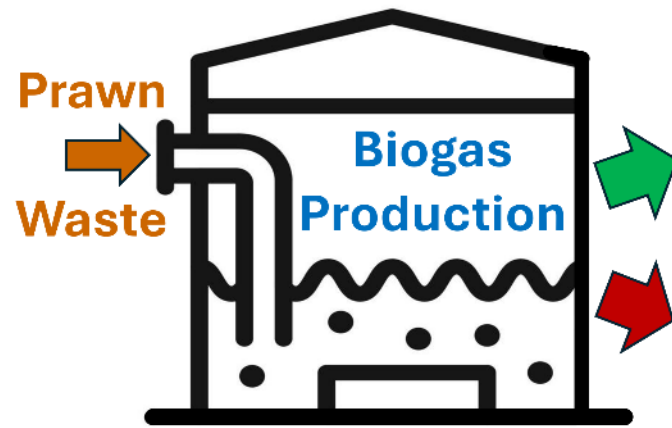
Compatibility of prawn waste with anaerobic digester biogas production.



Angus
Buckling



Pawel
Sierocinski



Anaerobic Digester (AD)

YES

Stable Microbiome
No impact on biogas?

NO

Unstable Microbiome
Reduced biogas

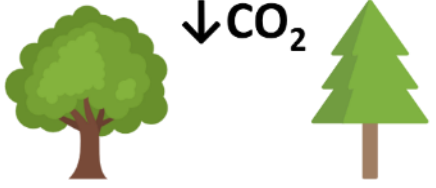


University
of Exeter

Recirculating Aquaculture Systems (RAS)

“Public Money for Public Goods”
(Nature Positive Food Systems)

CO₂ removal



New Agriculture Act
(25YEP)



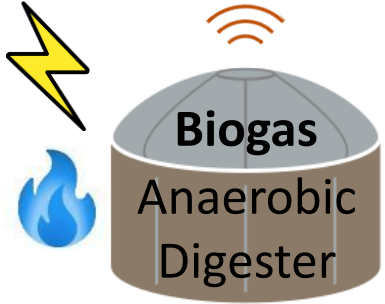
Biodiversity



Flood Risk



Waste Heat



Farm Wastes

“RAS-RES”
Recirculating Aquaculture Systems
powered by
Renewable Energy Systems

= land-efficient, low-carbon
alternative to seafood imports

Environmental Economic Modelling

RAS efficiency spares land for environmental improvements

King prawn  RAS farms are
>50 x more efficient land use for
animal protein than beef



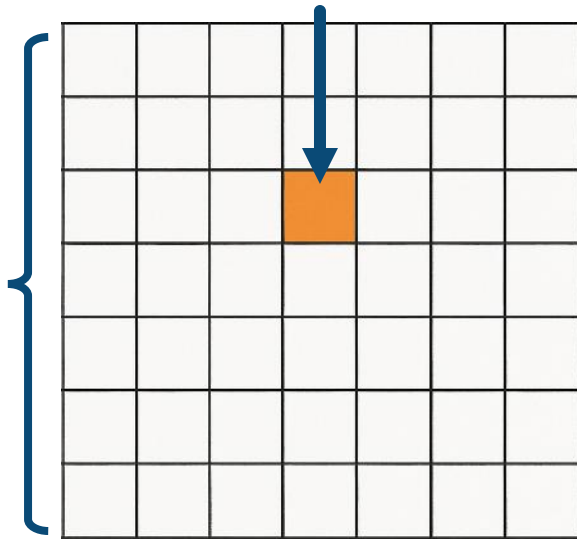
Ian Bateman
OBE



Thiago
Morello

Prawn Recirculating Aquaculture System (RAS)

Huge potential for ‘sparing’ farmland for
woodland (net-zero), conservation &
other environmental improvements
...**without** reducing UK food production



(>5x calories/ha than crops)



Morello et al. (2025). Sequestering carbon without reducing food production: the role of RAS. *Ecological Economics*
<https://doi.org/10.1016/j.ecolecon.2025.108692>

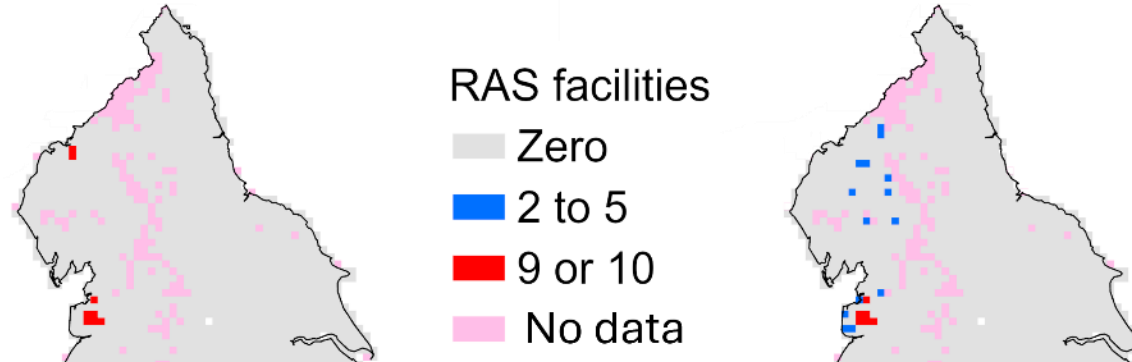
Morello et al. (In prep.) RAS can reconcile food supply and afforestation in Great Britain. *J. Cleaner Production*

Environmental Economic Modelling

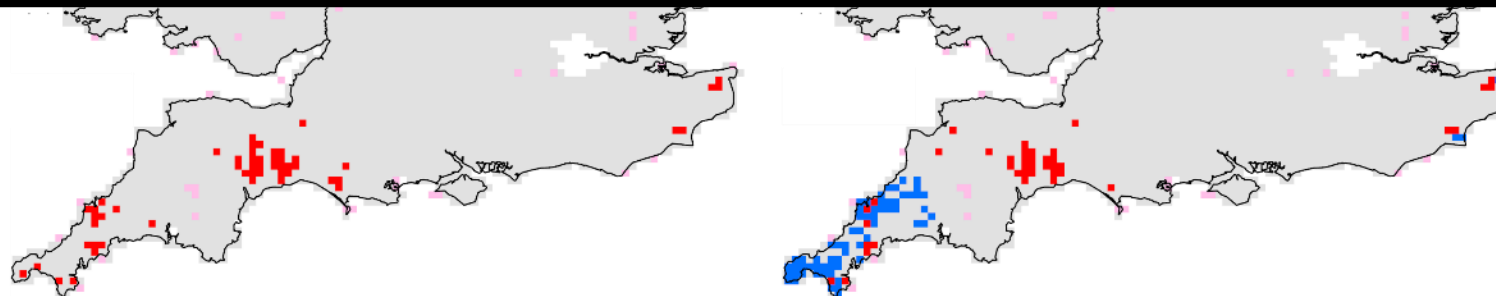
RAS most viable in areas of low agricultural opportunity, low employment costs, or lack of alternative options

No subsidies

CAPEX subsidies



Brown-field & urban sites with renewable energy options will expand viable areas even further.



King Prawn Demonstrator RAS Farm
(Near St. Andrews)



Rajesh Manchi
(PDRA)

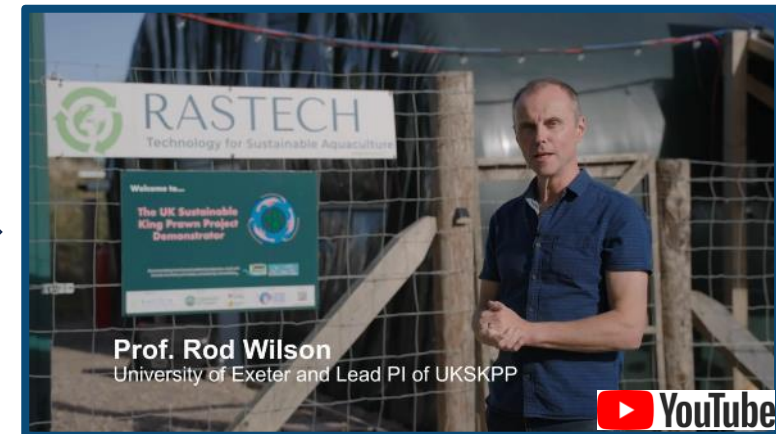
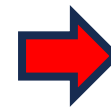


Andrew Whiston
(CTO RAStech)

Visitors:

- Politicians
- NGO's
- Environmental NGOs (eNGOs)
- Conservation Bodies
- Business people & investors
- Aquaculture industry
- Landowners
- Academics
- Students
- Seafood buyers
- Interested members of the local community

Watch 4-min
Demonstrator
video here



Overcoming barriers to UK expansion of RAS Seafood Production

Stakeholder engagement – Farming community



Caroline Voaden (South Devon MP & Chair of APPG for Shellfish Aquaculture)



The Regenerative Agriculture Festival
Lannock Farm, Hertfordshire (1-2 July 2025)



Wider outcomes for land-based seafood generally:

Policy Paper & Investment Prospectus

Launch and publication event –

Venue & Date TBC



Rob Ellis



Ian Bateman
OBE



Diana
Tingley



Daphne
White

Policy paper

**INVESTING IN THE UK'S
BLUE TRANSFORMATION:**
A world leading opportunity to deliver
innovative **land-based seafood** solutions

From left to right: King prawn (*Penaeus vannamei*), Shutterstock licence; Rainbow trout (*Oncorhynchus mykiss*), Stock licence - Zigmund Dlugavik; Sea lettuce (*Ulva lactuca*) cultivated in land-based Algal flow system, Image by Ocean Greens; Pacific oyster (*Magallana gigas*), Image by Patou Ricard from Pixabay.

Executive summary

The majority of global seafood consumption now comes from land-based seafood production (aquaculture) which needs to double by 2050 to meet rising demand. The UK has a unique opportunity to help meet this need by adopting and developing innovative land-based seafood production technologies, which can dramatically increase the supply and range of aquatic species farmed in the UK, both for domestic consumption and high-value export markets.

Widespread adoption of land-based seafood production technologies across the UK would create jobs, boost productivity, enhance domestic food security, support exports, drive international technology leadership and provide opportunities to meet sustainability targets.

A proposed solution

National Centre for Land-Based Aquaculture

Visitor centre –

engage UK public, provide education and awareness of sustainable seafood

Innovation hub –

space to bring industry and academia together to innovate



Hatcheries –

provide sustainable, reliable biosecure source of larvae

Regulatory Support –

provide training and advice for regulators and new operators

Training centre(s) –

provide courses to the emerging aquaculture workforce in the UK

UKSKPP Interpretation materials

UK Sustainable King Prawn Project

1 What's the challenge?

King prawns are hugely popular in the UK, but available product can be unsustainable for various reasons



Removing mangroves to make space for outdoor prawn ponds reduces CO2 storage, makes coastlines and inland farms more vulnerable, and damages juvenile fish nursery areas.



Potentially uncertain qualities of outdoor farming practices can affect consumer perceptions.



The carbon footprint of overseas production and import may outweigh that of a locally-produced product.

2 What's the solution?

Can we produce king prawns on UK farms in a cost effective and sustainable way which benefits the environment, by using Recirculating Aquaculture Systems co-located with heat from Anaerobic Digestors?"



3 How can we optimise?

—What is the optimal environment and feed needed to grow the healthiest and most nutritious prawns indoors on UK farms?

—Can we provide novel technology to improve the management of these environments?

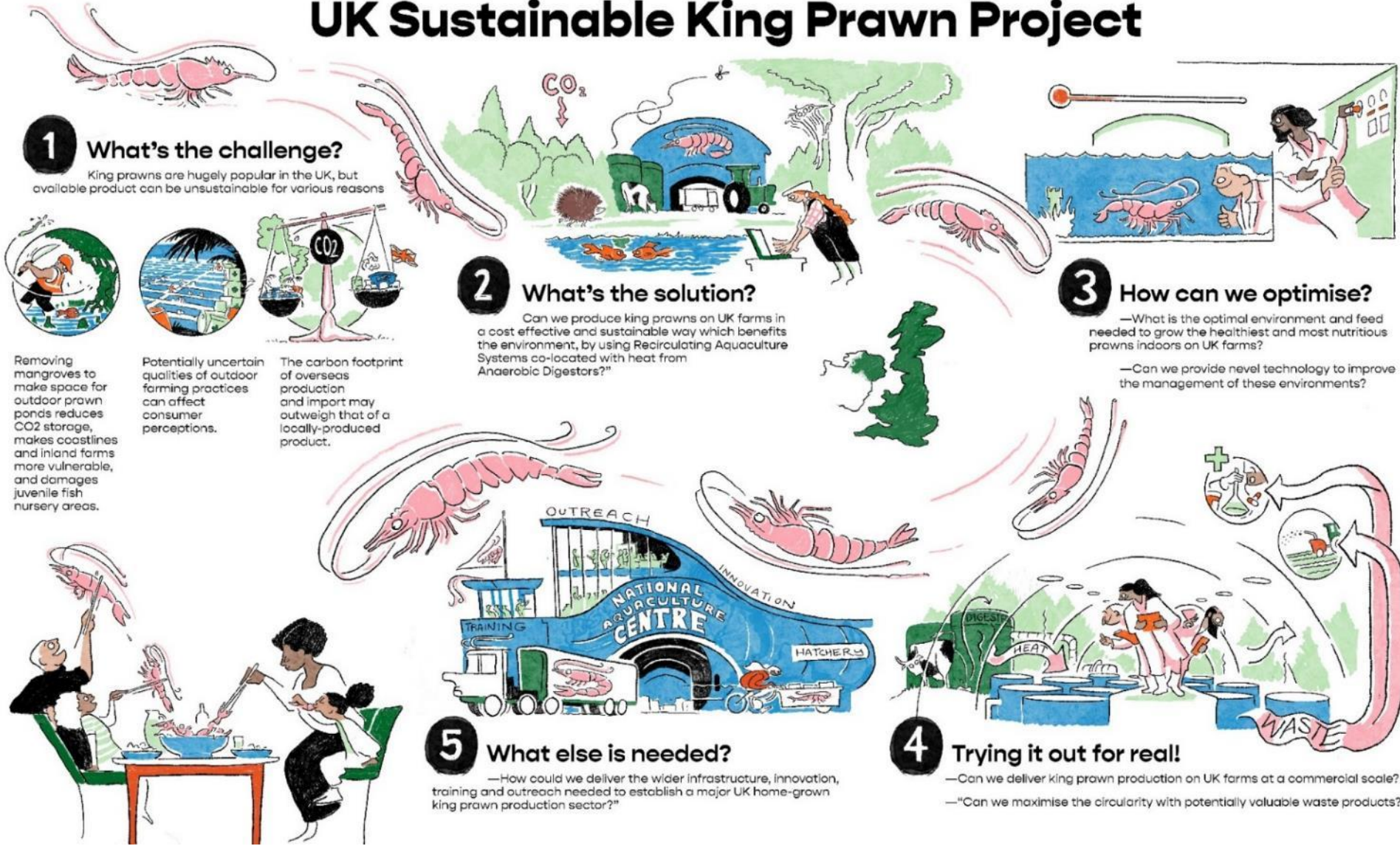
5 What else is needed?

—How could we deliver the wider infrastructure, innovation, training and outreach needed to establish a major UK home-grown king prawn production sector?"

4 Trying it out for real!

—Can we deliver king prawn production on UK farms at a commercial scale?

—“Can we maximise the circularity with potentially valuable waste products?”



Jonny Glover (Illustrator)

UKSKPP Interpretation materials

Infographic posters

What does it take to grow a prawn?
What goes in and what comes out, and what this means for prawns grown in a recirculating system.

Efficiency in energy use
Energy and heat use is carefully considered at each stage of the production system, to make farming tropical prawns in the UK economical and as sustainable as possible.

It's all about the water quality
A stress-free environment is key for fast-growing and healthy prawns. Although prawns are resilient, it is essential to maintain optimal water conditions to grow quality prawns in an efficient system.

Video tour



The King Prawn Demonstrator at RASTECH

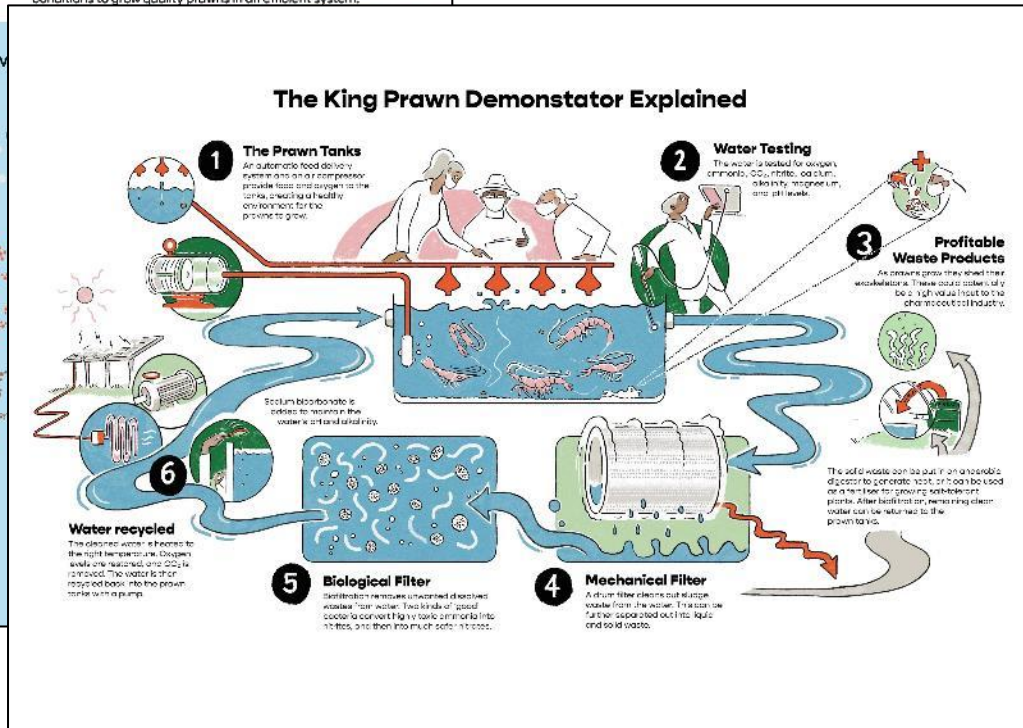


Sourcing the larvae



Efficiency in energy use

RASTEch



Feeding us! Why we love prawns

HEALTHY TO EAT

Low in fat, high in protein, prawns are a great source of essential nutrients. They are also low in calories and high in fibre, making them a healthy choice for those looking to maintain a balanced diet.

HEALTHY TO EAT

Prawns are a rich source of antioxidants, which help to reduce inflammation and protect against chronic diseases. They are also a good source of omega-3 fatty acids, which are known for their heart-healthy benefits.

HEALTHY TO EAT

Prawns are a great source of protein, which is essential for muscle growth and repair. They are also a good source of iron, which is important for maintaining healthy blood levels.

HEALTHY TO EAT

Prawns are a low-calorie food, making them a great choice for those looking to lose weight or maintain a healthy weight. They are also a good source of fibre, which helps to keep the digestive system healthy.

HEALTHY TO EAT

Prawns are a great source of calcium, which is essential for strong bones and teeth. They are also a good source of potassium, which helps to regulate blood pressure.

HEALTHY TO EAT

Prawns are a great source of zinc, which is important for immune system function. They are also a good source of selenium, which has antioxidant properties.

HEALTHY TO EAT

Prawns are a great source of phosphorus, which is essential for energy production and bone health. They are also a good source of magnesium, which helps to regulate blood sugar levels.

HEALTHY TO EAT

Prawns are a great source of iodine, which is essential for thyroid function. They are also a good source of copper, which is important for iron metabolism.

HEALTHY TO EAT

Prawns are a great source of manganese, which is important for bone health and metabolism. They are also a good source of boron, which is essential for brain function.

HEALTHY TO EAT

Prawns are a great source of vanadium, which is important for insulin sensitivity. They are also a good source of chromium, which helps to regulate blood sugar levels.

HEALTHY TO EAT

Prawns are a great source of cobalt, which is essential for vitamin B12 production. They are also a good source of molybdenum, which is important for detoxification.

HEALTHY TO EAT

Prawns are a great source of silicon, which is important for skin health and hair growth. They are also a good source of phosphorus, which is essential for energy production.

HEALTHY TO EAT

Prawns are a great source of sulfur, which is important for skin health and hair growth. They are also a good source of selenium, which has antioxidant properties.

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How to prepare and cook raw prawns | Good Housekeeping UK • 268K views • 9

How To Cook Raw Prawns | Good Housekeeping UK • 268K views • 9

#prawns #curry II keralastyle II | all mustard and curry leaf • 658K views • 9

Garlic Chilli King Prawns | Scott's Scottish Desi • 627 views • 4 years ago

King Prawn Chow Mein Recipe | Khin's Kitchen • 23K views • 3 years ago



Natalie Bridges, Abbie Bramwell - Bristol MSc Science Communication for a Better Planet

UKSKPP Outreach materials

Why grow seafood on land and how?

The drivers

Increasing global demand for seafood has put commercial capture fisheries (i.e. seafood caught in the wild) under greater pressure. In response, aquaculture became the dominant source of seafood production globally in 2022.

Seafood eaten in the UK is mostly the 'big five' – cod, haddock, salmon, tuna and prawns – which are either depleted or non-existent in UK waters. An estimated 80% of UK seafood demand is now met by imports from overseas!

Rising global seafood demand is driving the aquaculture industry to develop new technologies and more sustainable production methods.

The innovation

Indoor recirculating aquaculture systems (RAS) minimise the use of water by recycling, cleaning and retaining the majority (>98%) of water in the system. Their closed-loop and closed-environment nature means they can be placed away from the sea or inland water systems, can greatly improve biosecurity and animal health, and allow for optimisation of the production environment.

RAS can be set up anywhere, even in highly insulated polytunnels on farmland!

A key feature of indoor RAS is that they can be adjusted to mimic any natural environment. Species from any climate can be farmed anywhere!

The opportunity

RAS tanks could be sited throughout the UK, co-located next to sustainable heat sources, such as anaerobic digesters, which can also absorb organic waste from the system.

King prawns are one of the UK's favourite types of seafood. We currently import them frozen from tropical countries, where they are often grown using environmentally damaging practices. Tropical king prawns are a perfect species for growing sustainably in RAS in the UK, providing a favourite seafood, fresh and right on our doorstep. And it could be just the starting point!

RAS has the potential to grow a huge range of healthy seafood in the UK sustainably and close to market.

Illustration: Lizzie Clarke | The value of fresh seafood and aquaculture in the UK. Report for DEFRA, 2022. The UK's seafood is...
 Design by Martha Clarke. Illustration by Anna Chan & Martha Clarke.



(Martha Clarke - Bristol MSc Science Communication for a Better Planet)

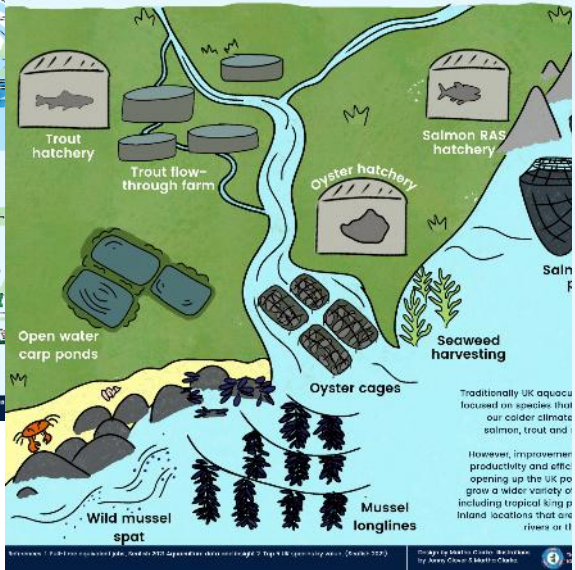
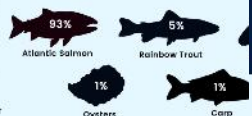
Current UK aquaculture production & methods

A valuable industry

The UK aquaculture sector has grown rapidly over the past 30 years to become a £1 billion industry, supporting 3,400 jobs. It is dominated by the industrialised Scottish salmon industry, which accounts for 83% of total value. The remainder of the sector is comprised of small to medium businesses, each employing less than 5 people.

A variety of production methods are in use from traditional land-based trout 'flow-through' to coastal salmon sea pens, oyster trellises, seaweed harvesting and mussel long-lines. RAS are currently used to grow salmon smolt and cleaner fish (for the salmon industry), as well as some trout, charr, catfish and tilapia.

Value of UK farmed fish and shellfish¹



Debunking myths about aquaculture

1 MYTH: "Aquaculture products are lower quality & less healthy than seafood caught in the wild"

FACT

Well-run, modern aquaculture systems can produce high quality, healthy fish. Tailored diets, close monitoring and controlled conditions maximise animal health. Production close to market can help to minimise transport and even freezing time, further benefiting product quality!



In an experiment, public participants preferred farmed fish over wild caught fish.

2 MYTH: "Farmed seafood is full of chemicals and antibiotics"

FACT

In the UK, chemical use in aquaculture is highly regulated and the routine use of antibiotics is illegal. Regulations are also in place to ensure products meet safety standards. Although standards exist for production elsewhere, there can be uncertainty around compliance.



King prawns being grown in an antibiotic-free environment.

3 MYTH: "Aquaculture is bad for the environment"

FACT

Whilst there have been historic problems with aquaculture (particularly with outdoor seafood production) indoor RAS provide a truly sustainable and controllable seafood production model that can work almost anywhere.



ASC (Aquaculture Stewardship Council) Look out for labels and the Good Fish logo which is sustainable.

What could the future of UK aquaculture look like?

New technologies, such as recirculating aquaculture systems (RAS), could be adopted in new settings, benefiting the environment, improving the choice of home-grown seafood for consumers and contributing to domestic food security.

Widespread adoption of RAS technologies could:

- deliver a more sustainable UK seafood future and reduce pressure on overfished wild-caught species;
- reduce carbon and environmental footprints by using renewable energy and alternative heat sources, maximising waste circularity and minimising inputs;
- provide UK consumers with a wider choice of locally-grown, high quality, nutritious seafood protein;
- free up traditional uses of farmland and be adopted in new settings.

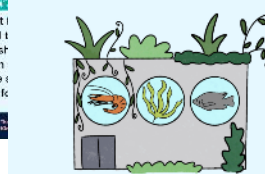


Traditional farmers adopting RAS, freeing up farmland to deliver environmental benefits, while maintaining domestic food security.

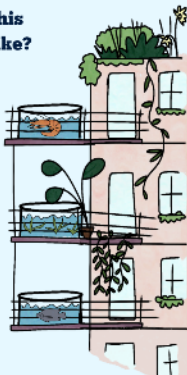
So, what could this new future look like?



Co-operative food production and distribution hubs, with home-grown tropical seafood at their heart.



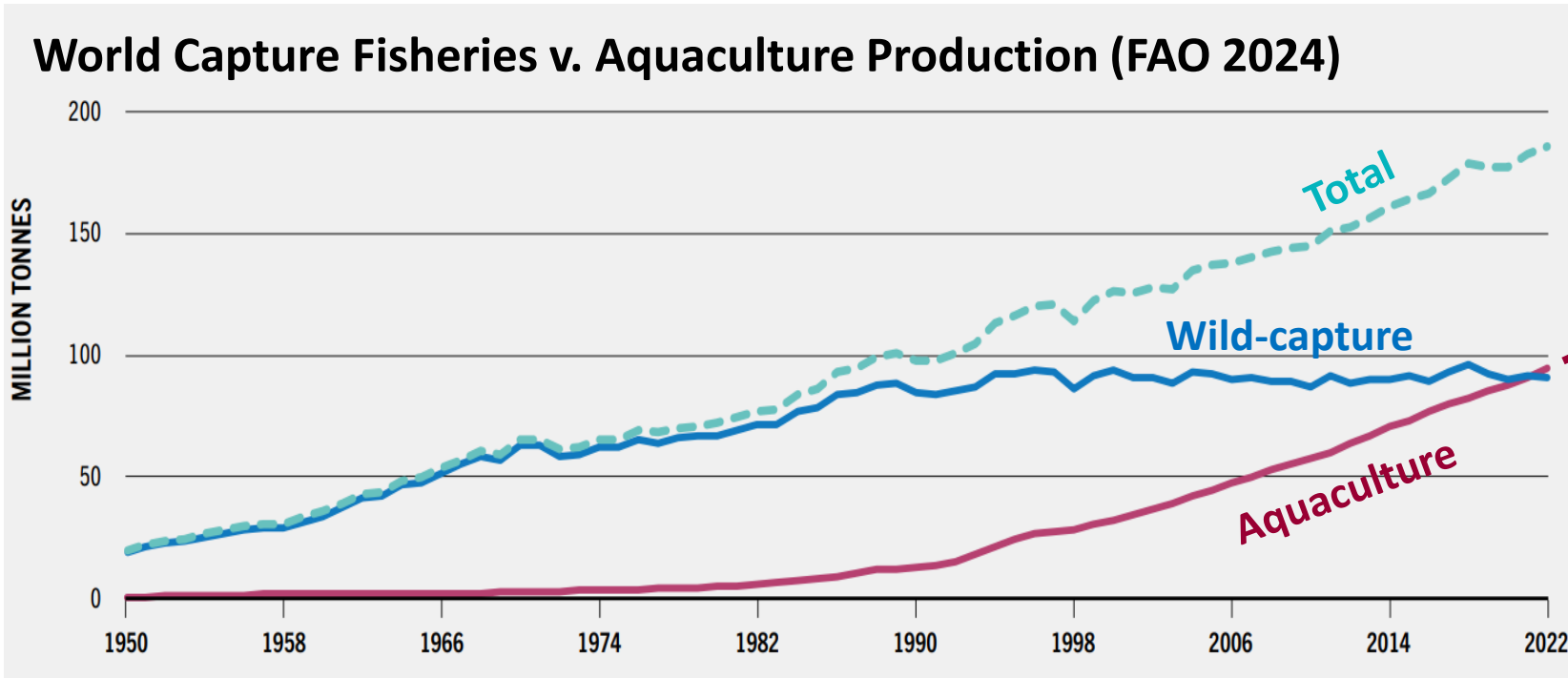
Urban RAS farms meeting local seafood demand, whilst also growing foliage using nutrient-rich tank waste to cool and green urban spaces.



Growing a range of plant and animal seafoods in domestic and unconventional settings!

Illustration by Anna Chan & Martha Clarke. Design by Anna Chan & Martha Clarke.

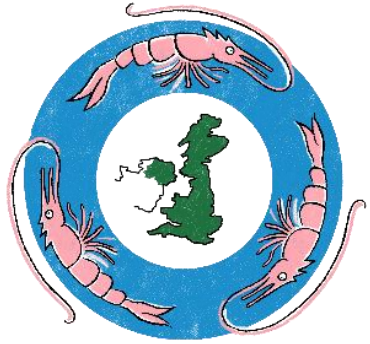
Global seafood production



Aquaculture production must double by 2050

Global seafood production – 222 Mt in 2022 (\$472 billion)

Aquaculture provides 59 % of seafood for human consumption



UK Sustainable King Prawn Project

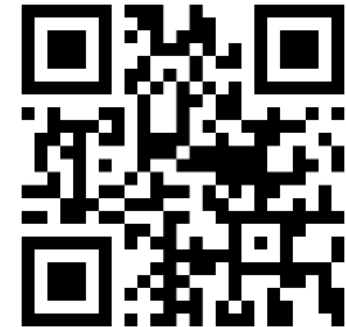


Land-Based Seafood



UKSKPP
Project Website

Thank You



King Prawn Demonstrator
RAS Farm Video



University
of Exeter



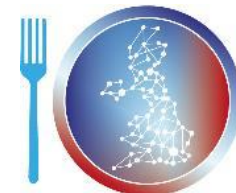
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