Interreg Atlantic Area
European Regional Development Fund

EUROPEAN UNION

access 2 sea

New Sustainable Aquaculture Techniques in the Atlantic Area Region

PROJECT IDENTIFICATION:
EAPA_1059/2018 – ACCESS2SEA

CEEI Bahía de Cádiz
Centro Europeo de Empresas e Innovación

WestBIC

ciimar
Centro Interdisciplinar de Investigação Marinha e Ambiental

Technopole Quimper-Cornouaille

INVESTIR EN FINISTÈRE

ctaqua CENTRO TECNOLÓGICO DE LA ACUICULTURA

UAlg UNIVERSIDADE DO ALGARVE

Údarás na Gaeltachta

CSAR 100 1920-2020 Swansea University Prifysgol Abertawe

NEW SUSTAINABLE AQUACULTURE TECHNIQUES IN THE ATLANTIC AREA REGION

INTRODUCTION

As part of the programme of work included in Work Package Six of the Access2Sea project, Action Four involved Project Partners undertaking to research and analyse new aquaculture techniques being developed in their regions. This research is aimed at fostering a more sustainable industry by facilitating the dissemination of techniques which could be of value in addressing the needs of companies in other territories of the Atlantic Area Region.

Table (i) below lists a selection of the new, sustainable aquaculture techniques which were identified by Access2Sea Partners across the five regions involved in the project. The full list of new, sustainable aquaculture techniques identified is detailed in later sections of this document.

Table (i) ***New Sustainable Aquaculture Techniques by Region***

Region	Technique	Reference / Link
Welsh Region	Biophillic living presentation: a 44 unit residential building in Swansea city centre with aquaculture in the bottom floor and waste from the fish being used to grow plants for consumption on the flat roofs	http://www.biophilicliving.co.uk/
Welsh Region	Cleanerfish – Investigation of the efficiency of *U. intestinalis* as a component of a land-based integrated multi-trophic aquaculture (IMTA) system.	https://thefishsite.com/articles/lumpfish-papers-win-swansea-awards
Welsh Region	Ocean Matters – Production of lumpfish to clean salmon of sea-lice	http://www.oceanmattersltd.co.uk/facility
Welsh Region	Cât-Y-Môr – Community Benefit Society implementing 3D ocean farming - a system that grows a mix of seaweed crops and shellfish - including mussels and oysters - under the water's surface.	https://carymor.wales/
Welsh Region	WalesACE – Aquaculture Centre of Excellence, Swansea University	https://www.swansea.ac.uk/bioscience/csar/projects/walesace/
Andalucía Region	Sustainable Wetlands Aquaculture - Sustainable use of wetlands within protected areas (or not) for extensive / semi intensive marine aquaculture activities	Walton, Mark & Vilas, Cesar & Canavate, Jose Pedro & A., Prieto & Van Bergeijk, Stef & Medialdea, J.M. & M., Librero & N., Mazuelos & King, Jonathan & Oc, Lee & Le Vay, Lewis. (2015). Policy Guidance for Sustainable Wetlands Aquaculture. 10.13140/RG.2.1.4579.7203
	Table Continued on following page	

Region	Technique	Reference
Andalucía Region	Integrated Multi-Trophic Aquaculture – an integrated culture of organisms of various species belonging to different trophical levels in the same water body	http://integrate-imta.eu/category/training-materials/ http://integrate-imta.eu/category/downloads/
Irish Region	Smarter Aquaculture – a multi-tenanted, cloud-based system where aquaculture users can upload, store, and analyse key farm production data	https://tssg.org/projects/smarter-aquaculture/)
Irish Region	AquaFarm is a novel modular recirculating aquaculture system (RAS) that enables low cost farming of aquatic species in high density	http://dit.technologypublisher.com/files/sites/dit-technology-to-license---aquafarm.pdf
Portuguese Region	Atlantik Fish Production Model	https://www.atlantikfish.com/en/production-model/
Brittany Region	Innovations presented at the *Salon National de la Conchylicutlure et des cultures marines including:* • Creation of a storing tray for closed systems (SMO SERVICE MAINTENANCE OSTRÉICOLE) • New range of ultra-light and economical bio-composite sieve tubes. Global solution for the purification of shells (Polyway) • New heat pumps and cooling units to cool or heat up basins (Aquassys) • New light working coats and equipment for aquaculture workers (Aquavitex) • Oyster tracker software to manage aquaculture farms (Eureka Mer)	https://www.salon-ostreiculture.com/en/innovations

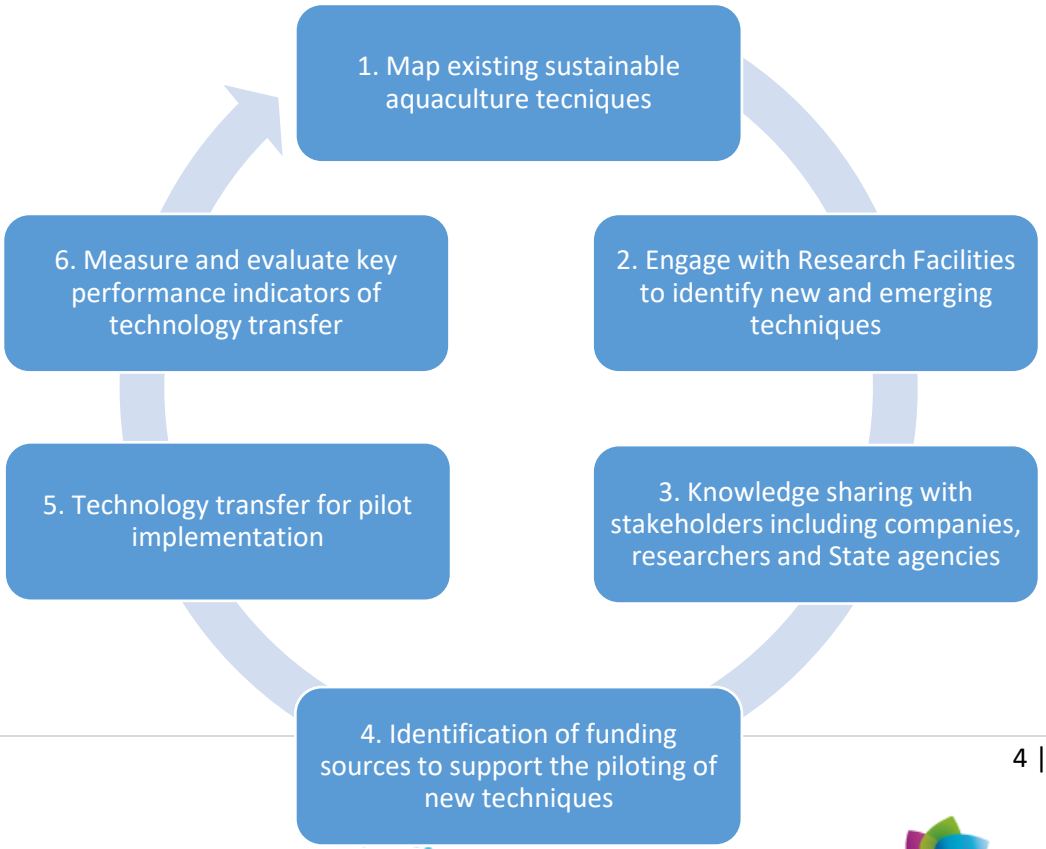
TECHNOLOGY TRANSFER ROADMAP

A Technology Transfer Roadmap has been developed by the Partners in the Access2Sea project as a methodology for the transfer of these new sustainable techniques transnationally across the project. There are six stages to the Technology Transfer process as follows:

Stage 1. Map existing sustainable aquaculture techniques
Stage 2. Engage with Research Facilities to identify new and emerging techniques
Stage 3. Foster key collaborations and strategic partnerships with industry, state agencies and other stakeholders for the purposes of knowledge sharing and dissemination.
Stage 4. Utilise Access2Sea Partnership to provide the signposting and introductions between research facilities and companies, and for identification of funding sources for pilot activities
Stage 5. Carry out technology transfer for pilot implementation
Stage 6. Measure and evaluate key performance indicators of technology transfer

Figure (i) below outlines the six stages of the Technology Transfer Roadmap

Figure (i) ***Access2Sea Technology Transfer Roadmap***



WELSH REGION

The following seven new sustainable aquaculture techniques were identified by the Welsh Partner of the Access2Sea Project, Swansea University:

1. Biophillic living presentation: this will be a 44 unit residential building in Swansea city centre with aquaculture in the bottom floor and waste from the fish being used to grow plants for consumption on the flat roofs (see attachment).
2. Cleanerfish production
3. Ocean Matters in Anglesey (now owned by Mowi) and 360 aquaculture in Swansea are both producing lumpfish to clean salmon of sealice
4. Smartaqua Project – expanding the non-food aquaculture businesses in Wales
5. Aquaculture Centre of Excellence, Swansea University
6. Pufa-Fish
7. Câr-Y-Môr – For the Love of The Sea

1) Biophillic Living

The vision for Biophilic Living Swansea is to enable reconnection with nature in the urban environment, and the creation of a cohesive community to tackle issues of social exclusion and loneliness in an innovative way. The project will allow residents to help run an urban farm as a social enterprise, with home grown produce consumed and sold locally. Biophilic Living is founded on research that reconnecting with nature is essential to our well-being, and that there are positive community and health outcomes from living more closely with the natural world.

The biophilic design promotes a relationship to nature throughout the project, including roof-top garden amenity space, living walls, balcony planters for each apartment, and greenhouses incorporating a vertical farm utilising aquaponics.
The philosophy of the project is to encourage community engagement and reconnect building users and visitors with nature in the urban environment. The longer-term goal is to change peoples' perception of urban living, and to monitor the health and well-being benefits of living alongside nature.

(**From**: http://www.biophilicliving.co.uk/ and http://www.biophilicliving.co.uk/biophilic-living-swansea-pre-application-consultation-now-underway/

2) Cleanerfish Production

Investigation of the efficiency of *U. intestinalis* as a component of a land-based integrated multi-trophic aquaculture (IMTA) system. IMTA systems use by-products from the culture of one species (in this case lumpfish) to enhance the growth in another (here *U. intestinalis,* which is also being used as the effluent remediation species)

From: https://thefishsite.com/articles/lumpfish-papers-win-swansea-awards

3) Ocean Matters, Anglesea - Creating sustainable solutions to the sea-lice problem

For the salmon industry and its supporting ecosystems, sea lice have become one of the greatest challenges, impacting all stakeholders significantly. Since its inception, Ocean Matters has acted with focus and urgency to combat this issue through the production of quality lumpfish and the continued development of effective co-habitation approaches. Their land-based farm is situated on the coast of Wales with optimal in-take systems so we can create and maintain ideal conditions in which to breed and raise lumpfish. Fresh seawater is brought into the aquaculture facilities daily from local waters where it is tested, treated and continually monitored to assure an ideal growing environment, creating superior growing parameters that promote robust health and maximum survivability through both deployment and lifecycle. Due to the extensive filtration systems and clean technologies the out-going water is clean and seamlessly reintroduced back into local waterways with no effect on the environment, surrounding life or native species.

The Ocean Matters' aquaculture campus is comprised of numerous controlled systems – each with technologies that assure precise environments specifically calibrated for lumpfish. Our systems incorporate highly sophisticated filtration, ozone, water management and monitoring technologies that enable acute control year-round.

From: http://www.oceanmattersltd.co.uk/facility

4) Smartaqua Project – expanding the non-food aquaculture businesses in Wales

Aquaculture – the production of aquatic organisms – is the world's fastest growing food industry, but it is also highly competitive**.** In comparison, the non-food aquaculture industry (e.g. production of cleaner fish and nutraceuticals from algae) is a niche market, driven by science. This project offers science based companies the following services:

- A network of researchers, aquaculture boards and multinational businesses
- Scientific expertise and guidance on fish and algae biotechnology
- Collaborative R&D project

From: http://smartaqua.org.uk/company/collaborations/attachment/360-aquaculture-poster/

5) Aquaculture Centre of Excellence, Swansea University

The Centre for Sustainable Aquatic Research at Swansea University is currently developing the first Aquaculture Centre of Excellence in Wales (WalesACE) to serve as a technological springboard and exemplar of integrated multi-trophic aquaculture (IMTA). This will support an increase in sustainable finfish production and high value micro-algae in Wales.

IMTA specifically targets the circular economy and represents an area where Wales can expand its Aquaculture potential and increase its food security through innovation and collaboration. WalesACE will develop rearing protocols for finfish, filter feeders and microalgae, which will suit the specific requirements of an IMTA system in Wales.

Within WalesACE fish will be grown in recirculating aquaculture systems where the waste from the fish will be processed into sterile dissolved nutrients, these in turn will grow microalgae in bio-fences. The microalgae will then be processed to produce feed for the fish and hence create a circular nutrient flow.

WalesACE will operate out of a purpose built structure containing two dedicated recirculating aquaculture systems, algal bio-fences and nutrient processing machinery. Each system will be capable of rearing fish in both fresh and saltwater as well as rearing species from cold to tropical climates.

From: https://www.swansea.ac.uk/bioscience/csar/projects/walesace/

6) Pufa-Fish

As the worlds most farmed fish at 7 million metric tonnes, Tilapia farming represents an important source of fish protein for many low income countries (LIC's). Over the next 18 months the Swansea University project's plan is to develop a global network of stakeholders who aim to raise human health standards in LIC's by creating systems to produce nutritionally enriched tilapia. A lot of fish in low income countries are produced unsustainably, are deficient in essential omega-3's such as Poly Unsaturated Fatty Acids (**PUFA**) and fish waste pollutes local waterbodies.

Based on decades of research expertise developed at Swansea University through the Centre for Sustainable Aquatic Research (CSAR), pump priming funds will strengthen an established SU-Zambia R&D partnership to lay the foundations for a much larger GCRF (approx. £2.6m) grant to pursue three main development opportunities:

- **Poverty alleviation** – Further strengthen the network of stakeholders the university is currently engaged with in Zambia to maximise impact. Work with local communities and members of the community in Siavonga who will benefit from the PUFA-FISH project. Ascertain the potential of community-led income generation initiatives that are based on

innovative fish farming techniques at a grass roots level. Case studies selected in 2019-2020 will form the basis of a larger operation in the coming years.

- **Improved nutritional value** – The project will develop a RAS that can be used in Zambia to improve the nutritional value of farmed tilapia by increasing the nutritional quality via the administration of novel microalgae diets developed as part of CSAR's SMARTAQUA project (~£2M). We will use participatory action to create a framework for farmers in Zambia. Parallel research will be conducted in the Wales Aquaculture Centre of Excellence (~£0.8M) 'Wales - ACE' currently under construction at Singleton Campus.
- **Reduction of waste** – Develop methods for near zero nutrient loss in the farming of tilapia and hence minimise any impacts on the environment. Use RAS, reuse waste plastic and improved tilapia strains to create low impact aquaculture systems.

From: https://www.swansea.ac.uk/bioscience/csar/students/phd/trevi/

7) Cât-Y-Môr – For the Love of The Sea

Cât-Y-Môr – For the Love of The Sea is a Community Benefit Society that grows and sells seafood using the 3D ocean farming model. The 3D Ocean Farming is a version of the Integrated Multi-Trophic Aquaculture system, where seaweeds (primary producers) and bivalves (filter feeders) are farmed on the same licensing site using the water column depth. The Society also aims to develop a sustainable seafood system including a seafood bistro, café, shop, an education and visitors centre. The key aim is to demonstrate and implement a Sustainable Seafood System that improves people's well-being and the coastal environment. This sustainable food system is supported by the Well-being of Future Generations (Wales) Act 2015 which states the ambition, permission and legal obligation to improve Wales social, cultural, environmental and economic well-being.

From: https://carymor.wales/

ANDALUCÍA REGION

The following three new sustainable aquaculture techniques were identified by the Andalucían Partners of the Access2Sea Project, FUNDACIÓN BAHÍA DE CÁDIZ PARA EL DESARROLLO ECONÓMICO & Fundación Centro Tecnológico Acuicultura de Andalucía:

1. Sustainable Wetlands Aquaculture
2. Integrated Multi-Trophic Aquaculture
3. Diversification towards Herbivorous / Omnivorous Culture Species (Emerging)

1) Sustainable Wetlands Aquaculture

Along the Atlantic coastline of southern Spain, it is common to find extensive aquaculture installations in wetlands where naturally-recruited shrimp and fish occur with production entirely supported by natural productivity. These enter the lagoons as larvae or juvenile passing through the sluice gates with the incoming estuarine water. Some of the lagoons have greater water exchange as they receive the water from semi-extensive seabass or seabream production that occurs in a row of culture ponds where fish are maintained at around 2-4 kg m-2 and nutrition comes from both inflowing natural production and formulated feeds supplied by hand or automatic feeders. Also, oyster production is a relevant practise in this area, being the natural morphology of the wetlands ideal to place oyster cages for growing out as well as for seaweed production.

A good example of this sustainable aquaculture technique is an extensive / semi-intensive installation which is located within Doñana Natural Park. According to the technical report published in 2015 *Policy Guidance for Sustainable Wetlands Aquaculture* (Annex 1), the primary function of this wetland, and the economic justification for the investment in its construction and operation, is the provision of aquaculture products. Lagoons are harvested periodically every 3 to 5 years by lowering the water level to concentrate the fish which are then collected by netting. In addition, 100-120 fyke nets are deployed daily around the farm for the continuous harvest of shrimp, with mullet and other fish also regularly caught as by-catch. Semi-extensively cultured fish are harvested three years after stocking. The combination of semi-extensive (stocked and fed) and extensive (natural recruitment and no feeding) culture systems result in a mean annual production of 820 tonnes of which extensive production accounted for just over 25%. Bass (*Dicentrachus labrax*) is the main semi-extensively cultured species plus some gilthead seabream (*Sparus aurata*) harvested after a three year growout period.

This technical report shows that the development of sustainable aquaculture in saltmarshes located along the Atlantic coastline of Andalusia helps to keep their uses avoiding the abandonment of this areas, as well as it has a positive impact on some sustainable factors which are listed below:

- Nutrients absorption (N and P)
- Carbon sequestration
- Primary productivity
- Habitats for species
- Maintenance of biodiversity
- Assimilation of primary productivity by wetland birds and aquaculture species
- Cultural services, Ecotourism and Scientific knowledge

Objective: Sustainable use of wetlands within protected areas (or not) for extensive / semi intensive marine aquaculture activities and (but not necessarily) being compatible with other activities or uses of the area

Reference: Walton, Mark & Vilas, Cesar & Canavate, Jose Pedro & A., Prieto & Van Bergeijk, Stef & Medialdea, J.M. & M., Librero & N., Mazuelos & King, Jonathan & Oc, Lee & Le Vay, Lewis. (2015). Policy Guidance for Sustainable Wetlands Aquaculture. 10.13140/RG.2.1.4579.7203

2) Integrated Multi-Trophic Aquaculture (IMTA)

An IMTA system is an integrated culture of organisms of various species belonging to different trophical levels in the same water body (but not necessarily at the same time), thereby guaranteeing a functional relation between the levels, i.e. an exchange of matter and/or energy among them. At the basis are the carnivores, usually fish that receive feed. Nutrients coming from fish excretions and feed rests will stimulate microalgae growth that serves as feed for bivalves (filter feeders), which will also feed on the feed rests directly. Finally, the nutrients from excretions from both fish and bivalves serve as a food source for seaweed cultures.

As part of the Atlantic Area Interreg Project, *INTEGRATE,* CTAQUA has designed, operated and evaluated IMTA culture in earthen ponds in an existing and operational oyster farm. The pilot experiment aims to demonstrate that cultivation of different marine species based on the principles of the IMTA-concept is viable in the earthen pond system. Furthermore, on a more scientific level, the pilot experiment aims to trace the nutrient flows in the system and to show how and where these are interconnected.

The pilot action is carried out in the *Salina de Belén de Poniente y de Levante*. This site, like many others in the area, is made of former salt evaporation ponds. Later, these were converted in fish cultivation ponds and the site has been in use for several years for the intensive cultivation of fish, mainly sea bass and sea bream. This activity ceased a few years ago, when intensive fish cultivation more and more took place indoor in recirculating aquaculture systems. In recent years, exploitation was taken over by Estero Natural, and activities are now mainly dedicated to oyster growing and extensive fish cultivation. Hydrologically it is connected to the inner zone of the Bay of Cádiz. Water exchange is driven by tides.

The IMTA consists of three trophical levels: fed fish (gilt-headed sea bream, *Sparus aurata*, dorada in Spanish), filter feeders (Japanese oysters, *Magallena gigas*, formerly known as *Crassostrea gigas*) and primary producers (seaweeds *Ulva ohnoi* and *Gracilaria gracilis*). Foliose Ulva species are being commercialised under the name sea lettuce (lechuga de mar in Spanish), whereas *Graciliaria* is sold under its Japanese name ogonori.

The INTEGRATE partnership consists of eight core partners and eleven associated partners from the five Atlantic Area Members States (Portugal, Spain, France, Ireland and United Kingdom), led by the Spanish aquaculture research organisation CTAQUA.

Objective: Maximize the input nutrient retention into harvestable products by making the most of the functional relations between different trophic levels

From: http://integrate-imta.eu/ and
http://integrate-imta.eu/category/training-materials/ and
http://integrate-imta.eu/category/downloads/

3) Diversification towards Herbivorous / Omnivorous Culture Species (Emerging)

Nutrition and feeding plays an essential role in the sustained development of marine aquaculture. Protein from marine resources is still necessary in fish feed formulations and then, the diversification towards herbivorous / omnivorous cultured species could be an option to address the issue of high protein % use in fish nutrition. Overall, marine and freshwater carnivorous species require 40-55 % dietary protein, while most freshwater omnivorous and herbivorous species require 30-40 % of their dry diet to be made up of protein. In the Atlantic Area of Andalusia there are some studies about the culture of Flat-head grey mullet (*Mugil cephalus*), omnivorous species with interesting future prospects in marine aquaculture production.

The project DIVERSIFY *(https://www.diversifyfish.eu/about-diversify.html)* has identified a number of new/emerging finfish species, with a great potential for the expansion of the EU aquaculture industry. Although the emphasis is on Mediterranean cage-culture, fish species suitable for cold-

water, pond/extensive and fresh water aquaculture have been included as well. These new/emerging species are fast growing and/or large finfishes marketed at a large size and can be processed into a range of products to provide the consumer with both a greater diversity of fish species and new value-added products. The fish species to be studied include meagre (*Argyrosomus regius*) and greater amberjack (*Seriola dumerili*) for warm-water marine cage culture, wreckfish (*Polyprion americanus*) for warm- and cool-water marine cage culture, Atlantic halibut (*Hippoglossus hippoglossus*) for marine cold-water culture, grey mullet (*Mugil cephalus*) a euryhaline herbivore for pond/extensive culture, and pikeperch (*Sander lucioperca*) for freshwater intensive culture using recirculating systems. These species were selected based both on their biological and economical potential, and to cover the entire European geographic area and to stimulate different aquaculture types.

From: https://www.diversifyfish.eu/summary.html

IRISH REGION

The following two new sustainable aquaculture techniques were identified by the Irish Partners of the Access2Sea Project, WestBIC & Údarás na Gaeltachta:

1. The Smarter Aquaculture project was identified from the activities of the Technology Software & System Research Group (TSSG) at Waterford Institute of Technology, Ireland

2. Modular Recirculating Aquaculture System which was developed at the Dublin Institute of Technology School of Engineering.

1) Smarter Aquaculture

Smarter Aquaculture is targeted at the Aquaculture sector and is focused on building on developing a multi-tenanted, cloud-based system where aquaculture users can upload, store, and analyse key farm production data. Smarter Aquaculture uses environmental factor forecast information and the aquaculture data and analyses it to predict and inform decision-making to optimise costs, minimise waste & maximise return.

Smarter Aquaculture is building the results of the Horizon 2020 project AquaSmart which saw the development of a cloud-based data analytics and benchmarking platform focused at Mediterranean species such as sea bass and bream. Smarter Aquaculture is extending this work in a number of ways:

- Platform capability extended to more contexts including onshore sites such as pond/ river and different species (e.g. salmon, trout),
- Intelligent meta data mapping system for easy on boarding and data uploads,
- Recognise environmental data (weather, tidal) and build models to predict impact on production KPIs,
- Use sensor data collection where feasible
- APIs to facilitate mobile data upload.

Smarter Aquaculture is a micro services based analytics platform focused on the issues facing the aquaculture industry. Building on the results of the Horizon 2020 project AquaSmart (https://tssg.org/projects/aquasmart/), Smarter Aquaculture is aiming to provide the following thus broadening the scope of the platform developed under AquaSmart:

- Build a historical repository of relevant environmental data (tide, weather, forecast) from sources such as MADIS (https://madis.ncep.noaa.gov/) and Copernicus (http://marine.copernicus.eu/)
- Application of machine learning techniques including regression models and time-series analysis to time series data collected from sensors, correlating with environmental data

- Application of analytics to producers in an Irish context, specifically fresh water trout, but also encompassing a dialogue with the salmon industry

Key Contact: John McLaughlin, Principal Investigator jmclaughlin@tssg.org

From: https://tssg.org/projects/smarter-aquaculture/

2) Modular Recirculating Aquaculture System

AquaFarm is a novel modular recirculating aquaculture system (RAS) that enables low cost farming of aquatic species in high density. The system is an above ground, modular shelving system where tanks are stacked and easily accessed with each sliding out as required. RASs are self-contained aquaculture systems that require minimal water exchange due to the internal recycling of water using both biological and mechanical filters. RASs overcome the constraints imposed by temperate climates and other environmental factors by providing a controlled, predictable and bio-secure environment for the culture species.

AquaFarm offers a lower cost and more ergonomically efficient RAS than existing commercially available systems. This type of system provides a flat pack alternative for farmers and food producers who wish to develop an aquaculture business of any scale. It can deliver a scalable modular model to the agrifood market that will allow existing aquaculturalists to diversify at a lower cost. It will also enable farmers and other food producers to diversify into marine aquaculture on a small scale. Novel aspects of the system include its portable self-cleaning tanks, modular framework, recirculation system and primary solids filtration system. Secondary fine solids filtration, aeration, pH control, water monitoring, data logging and alarm messaging systems are included within the primary solids filtration system.

From: http://dit.technologypublisher.com/files/sites/dit-technology-to-license---aquafarm.pdf

PORTUGUESE REGION

The following new sustainable aquaculture technique was identified by the Portuguese Partners of the Access2Sea Project, Centro Interdisciplinar de Investigação Marinha e Ambiental da Universidade do Porto and Universidade do Algarve, and are detailed in the Case Study below of Atlantik Fish

1) Atlantik Fish

The production of *Pescado da Maré* ® (*Fish from the sea*), in a semi-intensive regime, allows the food diet of our fish to be complemented with food that enters with water, and which grows naturally in the tanks, such as shrimps, polychaetes, algae, bivalves, crabs and others.

Tidal tanks will recreate the cycle and natural environment of the fish in the estuary and marsh areas, allowing fish to behave in the same way as wild fish. The feeding is complemented with natural food, which gives our fishes the appearance and to the meat the flavor and consistency identical to wild fish, resulting in a meat rich in Omega 3 and other polyunsaturated oils.

The fattening tanks were old salinas (salt ponds) that were converted into fish tanks, and were constructed only with the land existing in the sapal (saltmarsh), which allows to offer to the fish a natural environment, as for example, with water that enters in the tanks also enter juvenile fishes, wild flounders or eels, which then grow naturally within the tanks until they reach commercial size.

Another crucial feature for the quality of the sea bream and bass is the reduced number of fishes per tank, which allows them to have space to swim, rest and feed freely. This allows the meat a greater consistency and a uniform distribution of fat, achieving an identical quality to wild fish. The juveniles of sea bream and bass come from the best certified maternities, guaranteeing their biological and food safety, through the screening and traceability processes, thus reducing the pressure on wild fish stocks.

The company considers fishing as critical process in order to guarantee the quality of their fish. This is why it is done in the early hours of the day and using a traditional fishing net. After the siege, the fish is placed as quickly as possible in cold water, which allows them to die from thermal shock and not by asphyxiation or exhaustion, ensuring a rapid death and maintaining their characteristics and nutrients for a longer period of time. Then the fish is packed in a room, where all the parameters are controlled to guarantee quality and food safety for our customers, according to the HAACP standards. Packaging is carried out in a modern fish calibration and sorting line using the latest technology available on the market. Only in this way the *Pescado da Maré* ® (*Fish from the sea*) can ensure the traceability and monitoring standards of food quality throughout the production cycle.

More recently, the company has diversified the production by dedicating three tanks for the production of oysters. The oysters are oysters with a quality and quantity of meat that allow them to be classified as special oysters.

Reference: Plano Estratégico para a Aquicultura Portuguesa 2014 -2020. Direção Geral de Recursos Naturais, Segurança e Serviços Marítimos (DGRM). Ministério da Agricultura e do Mar.

From: https://www.atlantikfish.com/en/production-model/

BRITTANY REGION

A number of new sustainable aquaculture techniques were identified by the Partners of the Access2Sea Project from the Brittany Region, INVESTIR EN FINISTÈRE & Tecnopole Quimper-Cornouaille. They are listed below under the following categories:

1) Technological Innovations

2) Culture of New Species

1) Technological Innovations

- Innovations presented at the *Salon National de la Conchylicutlure et des cultures marines* (9th and 10th of October 2019) including:
    - Creation of a storing tray for closed systems (SMO SERVICE MAINTENANCE OSTRÉICOLE)
    - New range of ultra-light and economical bio-composite sieve tubes. Global solution for the purification of shells (Polyway)
    - New heat pumps and cooling units to cool or heat up basins (Aquassys)
    - New light working coats and equipment for aquaculture workers (Aquavitex)
    - Oyster tracker software to manage aquaculture farms (Eureka Mer)

- INTERREG Projects:
    - InvertebrateIT – New feed systems based on proteins from insects, one pilot project developed with the company Innovafeed (Technopole Quimper Cornouaille)
    - Integrate – CEVA and its partners aim at disseminating IMTA methods in the atlantic area (CEVA)

- Pole Mer's certified projects
    - Project VEGEAQUA aiming at identifying aquaculture species capable of being fed with vegetables instead of fish proteins (Ecloseries Marines de Gravelines)
    - Project A_FISH aiming at using fresh fish by-products to feed fishes raised in pisciculture (Halieutica)
    - PREDADOR 1 and 2 developing anti sea bream nets and alarm to protect oysters' farms (Actris)
    - PERLE 1 and 2 projects – restoring of native oysters in Brittany (CRC Bretagne Nord)

- Other innovations and projects:

  - Multizone - an Automatic feeding system for finfish aquaculture developed by Westair
  - Development of an offshore Integrated Multi-trophique Aquaculture farm with seaweeds and trout (Symbiomer)
  - 22 sites of production having Recirculating Aquaculture Systems in France (figure combining marine and freshwater environment)

2) Culture of new species

- Development of polyculture: In the Brest area, about 80 percent of aquaculture farms are focusing on the development of only one species. However, thanks to the development of sea weed cultures, new innovative types of farming have been launched. For instance, it is now possible to produce shellfish in deep water thanks to the multi trophic aquaculture approach.
- HoloFarm project: Development of *holothuriculture* (sea cucumbers), it is financed by the National EMFF, it aims at offering 3 new species: *Holothuria forskali,* H*olothuria tubulosa and Parastichopus regalis* – *(*AQUA B)
- Bio abalone production (France Haliotis)
- Development of king prawns without antibiotics, pollution and freezing (Lisaqua)
- Project SC2E – cultivating tropical prawns in Brittany (Martrop)
- Development of the production of the variegated scallop (Ferme marine de l'Ile d'Arun)
- Cultivation of macro-seaweeds in offshore environment, on around 150 hectares (Algolesko)

References:

- Program of the *Salon National de la Conchylicutlure et des cultures marines :* https://www.salon-ostreiculture.com/en/innovations

- Étude sur la pisciculture en circuit « recirculé » - Rapport final 2019, from : https://www.franceagrimer.fr/Actualite/Filieres/Peche-et-aquaculture/2019/Etude-sur-la-pisciculture-en-circuit-recircule-Rapport-final-2019

- List of the pole mer's certified projects: https://www.pole-mer-bretagne-atlantique.com/fr/ressources-biologiques-marines

Lead Partner

CEEI Bahía de Cádiz
C/ Manantial, 13. Edificio CEEI
Polígono Ind. Las Salinas de San Jose Bajo
11500 El Puerto de Santa María (Cádiz) - Spain
Tlf: (+34) 956 860 654 / Fax: (+34) 956 860 028
E-mail: asuarez@ceeicadiz.com
Web: www.ceeicadiz.com

Partners

Centro Tecnológico de Acuicultura de Andalucía
Muelle Comercial S/N
11500 El Puerto de Santa María (Cádiz) - Spain
Tlf: (+34) 956 56 93 63
E-mail: mm.agraso@ctaqua.es
Web: www.ctaqua.es

Swansea University
Centre for Sustainable Aquatic Research
Wallace Stores, Singleton Park
SA2 8PP - Swansea
Tlf: +44(0) 1792 29 53 83
E-mail: p.n.howes@swansea.ac.uk
web: www.swansea.ac.uk

Údarás na Gaeltachta
Na Forbacha, Co. Dublín. Galway
Tel: 091-503100
Fax: 091-503101
E-mail: foh@udaras.ie
web: www.udaras.ie

Innovation & Management Centre
CLG T/A WESTBIC
11 Galway Technology Centre, Wellpark Road
Galway, H91 E2W5 - (Ireland)
Tlf: (+353) 86 2574978
E-mail: smccormack@westbic.ie
web: www.westbic.ie

Technopole Quimper Cornuaille
2 rue François Briant de Laubriere
29000 Quimper - Francia
Tlf: +33(0)298 100 200
E-mail: rachel.sellin@tech-quimper.fr
web: www.tech-quimper.fr

CIIMAR | Interdisciplinary Centre of Marine and Environmental Research of the University of Porto
Novo Edifício do Terminal de Cruzeiros do Porto de Leixões
Avenida General Norton de Matos, S/N
4450-208 Matosinhos | Portugal |
Tlf: (+351) 223 401 852
E-mail: rodrigo.ozorio@ciimar.up.pt
web: www.ciimar.up.pt

University of Algarve
CRIA - Pavilhão B1
8005-139 Faro (Portugal)
Tlf: +351 289 800 097
E-mail: ajmarq@ualg.pt
web: www.ualg.pt

Investir en Finistere
46, quai de la Douane
CS 63825 29238, Brest cedex 2
Tlf: +33 (0)298 339 773
E-mail: a.coppens@investir29.fr
web: www.investir29.fr

Associated Partners

- Technopole Brest Iroise
  www.tech-brest-iroise.fr
- Cuideachta Feamainn Turtar Gorm Teo (TSC – Bleu Turtle)
  www.theseaweedcompany.com
- Association of Aquaculture Marine Businesses of Andalusia (ASEMA)
  www.asemaonline.com
- Union Chamber of Algae and Marine Vegetables (CSAVM)
  www.chambre-syndicale-algues.org

Interreg Atlantic Area
European Regional Development Fund
EUROPEAN UNION
access 2 sea
www.access2sea.eu