Interreg Baltic Sea Region

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BLUE ECONOMY TETRAS

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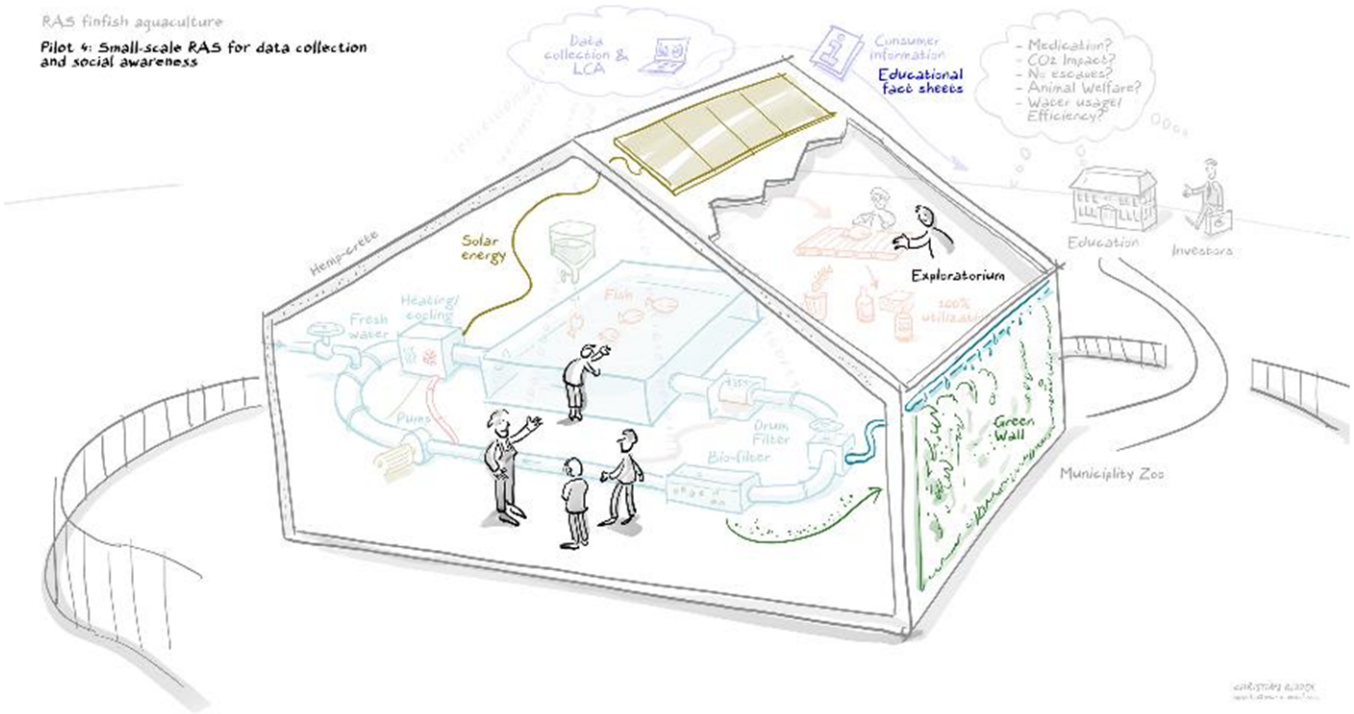

Feasibility Study

Pilot 4 – Small-scale RAS and Aquaponic Demonstration - for Communication and Social Awareness

GULDBORGSUND MUNICIPALITY

Project co-funded by Interreg Baltic Sea Region

Table of Contents

Context of the report

This feasibility study has been prepared as part of Pilot 4 of the TETRAS project. TETRAS is a three-year project funded by Interreg Baltic Sea Region that aims to improve the economic and environmental sustainability of recirculating aquaculture systems (RAS) by demonstrating new concepts of industrial symbiosis where RAS are placed strategically or combined with industrial processes to increase resource efficiency (water or energy) while producing affordable and healthy food. The project will develop tools and standards to assess and monitor RAS and promote investment, cluster creation, and expansion of these food systems. TETRAS is led by a consortium of research organisations, academic institutions, local authorities and business organisations and is supported by Interreg Baltic Sea Region under the Water-Smart Societies programme – Blue Bioeconomy.

Pilot 4 aims to use a small-scale RAS and aquaponic demonstration plant for communication and social awareness raising. This will be done by involving the educational facilities of the Center for Education Lolland-Falster (CELF), the Technical and Trade Gymnasium and Gastronomic vocational school in Nykøbing F., Denmark, hereby allowing hands-on experience and real-time data collection for the development of educational studies and communication materials based on factual information.

In addition to educational facilities, Pilot 4 will be available for visitors from the traditional farming sector and to aquaculture value chain stakeholders. This with a view to the promotion of a potential new food system for the region. At TETRAS project level, Pilot 4 aims also to provide a frame for a cross-pilot working group in communication and awareness.

This study will assess the feasibility of the use of the physical Pilot 4 small-scale RAS demonstration to create and strengthen factual information as communication and social awareness materials for target groups.

Executive Summary

Pilot 4 aims to promote the sustainability and increased food security of a RAS aquaponic production, by developing communication and awareness-raising materials through education using factual information based on hands-on experience.

The UN forecasts the population growth to peak at 10.4 billion in 2086. At the same time meat consumption is expected to increase by 20-40% per capita. This massive future demand for protein sources can only be met by replacing meat from land animals at least partially with protein from aquatic sources. But as wild stock has been depleted and the oceans in general, and the Baltic Sea in particular, are under pressure, it is necessary to reevaluate how ‘blue’ protein is produced.

Although RAS aquaculture holds the potential of becoming a solution to the future animal protein deficit, it faces the challenge of having a consumer segment that is either unaware of its environmental and health benefits, or worst case, that is directly opposed to the concept of fish-farming in a closed container system, due to misconception regarding fish welfare and fish meat quality. Therefore, the facts and findings regarding RAS aquaponics in a contained environment need to be communicated in a positive and targeted way in order to highlight the benefits, such as resource efficiency of feed (food conversion ratio), water management and environmental benefits, such as waste collection and recycling of

nutrients, disease control and protection of wild stock and the protection of our delicate Baltic Sea ecosystem, as well as improving food security with local year-round food production.

Background

The Baltic Sea Region and fish consumption

According to the European Commission[1], the average annual consumption of fish in the EU is 24kg per person, ranging from 6kg – 59.9kg per person. In the Baltic Sea Region, there is a distinctive difference between consumption in the eastern and western Baltic countries – with the eastern countries lying around 10-13kg fish per person, compared to around 25kg fish per person in the western countries. The species of consume fish in the EU are also limited, with tuna, salmon and cod being the most popular, little of which originates from Baltic waters and where today's catch mainly consists of small cod, herring and sprat[2]. It is, however, recommended to limit consumption of Baltic Sea fish to 1-2 times a month (125 g)[3] due to the high levels of dioxin content.

With this in mind, an increase in production of fish in the Baltic Sea region must consider both the environmental impact, species selection and health aspects of the product; something which can be accommodated within a RAS fish production.

Guldborgsund Municipality is surrounded by the Baltic Sea and is one of the largest farming municipalities in Denmark. The most recent environmental impact figures show that nutrient leaching in our area of the Baltic Sea is excessive[4], of which one of the consequences will be further restrictions on the amount of fertilizer allowed on farmland. Sea cage farming is under pressure from the government[5] and environmentalists and there is no room for expansion in the Danish Sea Plan[6].

With the development of RAS systems, a new form of animal husbandry in the form of RAS fish farming could be encouraged to be adopted by practical show casing and communicating fact-based information and capacity building networks, for the benefit of farmers, consumers and the environment at the same time.

There are many political statements regarding the benefits of increasing consumption of fish, both for health reasons and environmental sustainability, i.e. WHO conclusion that the "*Consumption of fish provides energy, protein and a range of essential nutrients* and that *consumption of fish, particularly fatty fish, lowers the risk of coronary heart disease mortality*[7]*"*, "The Shrinking Brain" refers to the importance of sustaining the balance of the human brain in omega-3 and 6 fatty acids and its relation to our

[1] https://oceans-and-fisheries.ec.europa.eu/facts-and-figures/facts-and-figures-common-fisheries-policy/consumption_en
[2] UNEP
[3] Fødevarestyrelsen
[4] Rådgivningsnotat fra DCE – Nationalt Center for Miljø og Energi (2023) Iltsvind i danske farvande 24. august – 21. september 2023 (https://dce.au.dk/fileadmin/dce.au.dk/Udgivelser/Notater_2023/N2023_44.pdf)
[5] https://fvm.dk/nyheder/nyhed/nyhed/slut-med-flere-eller-stoerre-havbrug-i-danmark
[6] https://havplan.dk/da/page/info
[7] Report of the joint FAO/WHO expert consultation on the risks and benefits of fish consumption

intelligence levels[8], WRI indicates that replacing meat from land animals with fish will reduce the carbon and feed footprints dramatically (*figure 1*).

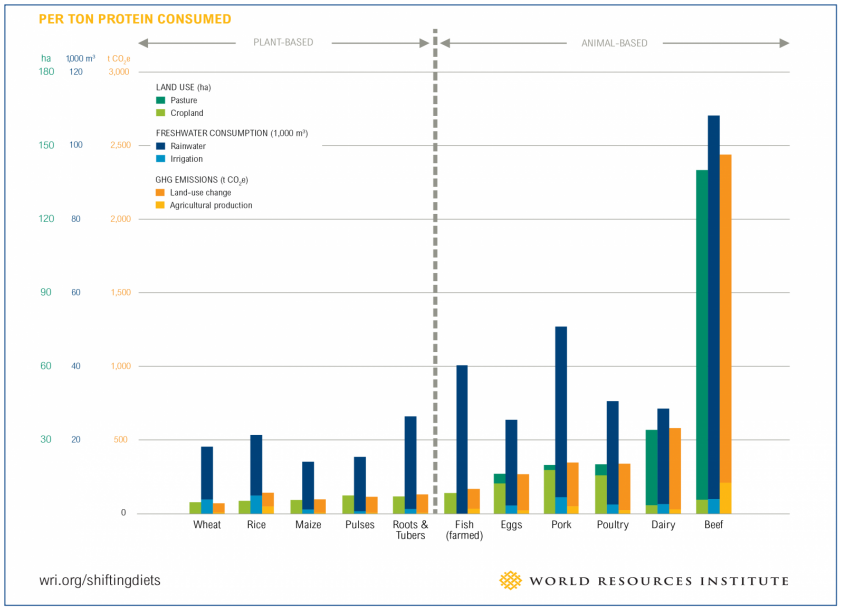

Figure 1: Animal-Based Foods are More Resource-Intensive than Plant-Based Foods[9]

With the depletion of wild fish stock in our region, it will also be necessary to reevaluate how the blue protein is produced, to avoid putting aquatic sources, our seas and wild fish stock under further pressure. One of the most promising solutions supporting this action is RAS production in symbiosis with traditional farming and/or plant production.

However, some of the largest identified barriers to increasing the consumption of fish in our region is in the mindset and eating habits of the consumers themselves.

- Our region consumes a very limited amount and variety of fish compared to other EU regions[10], where sea water is higher in salinity and there is a higher naturally occurring variety of species locally sourced.
- Our consumers are very conservative in their choice of fish species for the table[11].
- There are negative image issues regarding closed system fish productions – both regarding stocking density (animal welfare[12]) and off-flavour (taste of traditional freshwater pond

[8] Weekendavisen nr.37: "Hjerne på skrump" Chronicle of Ole G. Mouritzen, prof. Emeritus, Copenhagen University, on Crawford & Marsh, "The Shrinking Brain and the Global mental Health Crises", 2023
[9] Animal-based Foods are More Resource-Intensive than Plant-Based Foods | World Resources Institute (wri.org)
[10] https://oceans-and-fisheries.ec.europa.eu/facts-and-figures/facts-and-figures-common-fisheries-policy/consumption_en
[11] https://politiken.dk/mad/madnyt/art5478732/Nej-tak-Se-10-gode-fisk-og-skaldyr-som-vi-sender-ud-af-Danmark
[12] https://faunalytics.org/consumers-care-about-fish-welfare/

aquaculture fish[13]). Belgian researchers[14] have found in an explorative study indication that consumers' opinions and beliefs about farmed fish are mainly based on emotion and image transfer from intensive terrestrial livestock production rather than on awareness and factual knowledge of aquaculture.

- RAS technology is widely misunderstood or unknown and therefore its potential is not understood well enough to be an attractive alternative to open sea-cage fish production.

RAS production, resource management and social awareness

Recirculating aquaculture systems (RAS) are systems which enable fish to be grown on land. By recirculating and filtering the water, water usage can be reduced from 30 m³ per kg/fish produced in a flow-through system to 30 litres/kg fish produced in RAS (coupled up to denitrification and phosphorus removal[15]). Unlike conventional pond or open water aquaculture, the continuous recirculation in a RAS system enables control of the production conditions, collection of nutrient bi-products, isolation from wild fish stock and therewith restricted transmission of diseases and parasites. In this way, a RAS production supports the recycling of nutrients and water resources as well as protecting the environment. The recycling of nutrients and water resources can be used in a plant production – either through traditional farming or through aquaponics.

Focus areas identified for communication of RAS and plant production

The following subject areas have been identified for the development of communication materials regarding RAS and plant production:

- Healthy animal protein and fatty acid profile
- Resource efficiency – water and nutrient recirculation, food conversion ratio, plant growth
- Water quality and food security, antibiotic treatment-free
- Food supply and security - isolation from climate related and geographical factors
- Protection of wild stock and environment (climate impact)
- Full control of production parameters, year-round production (fish and aquaponics)
- Potential new value chain – local production of new species

In a recent study Lopez-Mas, Laura et al (2023), 16 identified 4 segments of consumers according to the consumers' beliefs, which were labelled accordingly: Ambivalent, Pro-aquaculture, Pro- wild fish and Impartial. It was concluded that "Results obtained may be helpful to provide each segment with tailored

[13] https://www.sciencedirect.com/science/article/pii/S0144860912000192#bib0020
[14] Verbeke W et al (2007) Consumer perception versus scientific evidence of farmed and wild fish: exploratory insights from Belgium Aquacult Int (2007) 15:121-136 D OI 10.1007/S10499-007-9072-7
[15] Bregnballe (2022)
[16] Lopez-Mas, Laura et al (2023) European consumers' beliefs about the main pillars of the sustainability: a comparison between wild and farmed fish https://link.springer.com/article/10.1007/s10499-023-01070-2

marketing strategies to stimulate farmed fish consumption and improve the overall image of the aquaculture sector to foster its full development in Europe." We aim to build on this knowledge.

Outline of the pilot project

Description of the pilot

Our feasibility study concerns a small RAS demo-size farm combined with an aquaponic set up for *communication and social awareness purposes*. The factual information gathered during the project lifetime will be used for social awareness-raising purposes and the development of educational materials around RAS African Catfish (*Clarias Gariepinus*) production and aquaponics for potential future stakeholders and consumers, providing the capacity to test and prove concepts (e.g. nutrient uptake from water by plants) in a real-life, small-scale pilot facility.

Operating an aquaponic system effectively requires knowledge of both aquaculture and hydroponics, which can be a deterrent for potential stakeholders, i.e. the maintaining of optimal water quality parameters (e.g., pH, ammonia levels, dissolved oxygen) requires monitoring and adjustment, RAS and aquaponic systems rely on pumps, monitors and other electrical equipment for circulation and aeration, and budding RAS fish farmers need to become confident with these technical features and equipment.

As the feasibility study is being conducted in order to highlight the possibility of symbiosis between water and nutrient management in aquaculture and plant production for future stakeholders and farmers, the availability of a physical demonstration plant is a very strong communication and awareness-raising tool.

The project timeline for the pilot is from August 2024 until November 2025. During this time, the pilot will also provide data for LCA and hands-on practical experience for the students at Nykøbing F. Business & Technical Gymnasium, CELF.

Methodology

Using digital and written medias it is possible access knowledge about anything at all levels from scientific reports to SoMe posts. In order to ignite genuine interest in a topic that is totally new in our region, we plan to invest time in engaging various target groups using the RAS/aquaponic physical pilot as a common platform.

We will start locally with main target groups being farmers, students at the local higher education and vocational school, university students as well as business and agriculture organizations.

- Already before the pilot is up and running, we will invite the higher education students to participate in capacity building in preparation of learning how to look after the fish and plants.

- The knowledge gained will be made available on a digital platform and reachable from the pilot site via QR codes, so visitors can read or maybe hear about feed, growth rates, species characteristics etc. on their own digital device.
- The students will plant greens that can be used in the gastronomy line education and canteen. These will be harvested as required.
- The fish water will be tested for nutrient content before and after having been passed through the plant aquaponic system.
- After harvesting the fish, the gastronomy line education and the canteen at the vocational school will be involved and tastings will be arranged as part of tours and seminars centred around the pilot plant.
- All above activities will be documented, pictures taken and progress and results shared via SoMe – if all goes well on both the students' own platforms, as well as TETRAS project partners´.
- It is important to maintain the SoMe activity levels to keep a positive awareness spiral going.
- We will have the opportunity to communicate our partners´ pilot progress and share knowledge with their networks´ about our experiences with RAS, aquaponics and social awareness.

In order to measure whether we have made any impact on consumers / social awareness, we will distribute short questionnaires to determine their knowledge and standpoint, both before and after tastings/visits/seminars. This will be followed up with quantitative interviews 6 months later.

In the long run, the knowledge that young people gain about aquaculture through hands-on experience with the pilot may encourage them to choose an aquaculture educations and consequently increase the future numbers of skilled workforce available for the aquaculture sector.

The pilot will provide a basis for practical knowledge sharing – the first local fish farmer on Lolland-Falster will not be alone - but can access support from the people involved in the running of the pilot.

The RAS equipment we have chosen for the pilot is state of the art, a small-scale RAS replica of a commercial production in Sweden. It is a system designed for commercial small/medium scale use and can be installed in former farm buildings. (The system is approved by Swedish IP Sigill AB, based on ISO 17067 and accepted by Swedac (Swedish accreditation authority), which is adapted for the Nordic region based on scientific findings.) The climate, legislation and geographical conditions in the Nordic countries are different from the rest of Europe. For example, significantly less plant protection products and antibiotics are used and the labour market works differently. The IP standard is designed to take advantage of this[17]. In this way, we will also give visiting farmers the opportunity to visualise a future fish production in their own buildings.

[17] Sigill AB "Om IP Standarden"; https://www.sigill.se/om-ip-standarden/

We have chosen the African Catfish for our pilot, based on earlier experiences with the species during the SB Interreg InnoAquaTech project[18] and on studies made by the university college, Absalon.

We believe that through social awareness and communication, we can encourage the introduction of a new eating fish to the Danish market that is a promising species for RAS aquaculture for the following reasons: Clarias (*Cl. Gariepinus*) is:

- High in fatty acids incl. omega 3
- A robust healthy fish with no/very low need for medication – good choice for "beginners"
- Very neutral in taste – an ideal family fish? There is not much research covering how the market accepts Clarias, however a group of university college students have made promising observations[19] in a small study where they developed and introduced Clarias convenience dishes to kindergarten children and families, who liked the fish and frequent comments were the lack of "fish taste".
- Already gaining acceptance and available in Swedish and German supermarkets
- Funny looking fish that can "walk" - with both lungs and gills - ideal for storytelling

During the project a Life Cycle Assessment (LCA) on energy and nutrient recycling will be made. Results from this project activity of course also will be a basis for communication. Access to the demonstration facility be will open to stakeholders (schools, universities, local authorities, business developers, interest groups) upon request.

Figure 2: Cover: "African Catfish; Clarias Gariepinus – from a strange fish to a tasty convenience product", Rikke Højer, ABSALON

[18] https://southbaltic.eu/-/innoaquatech-cross-border-development-and-transfer-of-innovative-and-sustainable-aquaculture-technologies-in-the-south-baltic-area

[19] https://www.bioguldborgsund.dk/media/nlui4obi/aalemalles-vej-til-danske-forbrugere-absalon-studieprojekt-rikke-hoejer-28-04-21.pdf

Overview of Alternatives

Proposal 1: Use of a physical pilot demonstration as an interactive communication platform

Figure 3: SWOT Analysis – physical pilot demonstration

Strengths	Weaknesses
Strong visual presence – seeing is believing! Inspirational "hands-on" demonstration facility for interactive learning Provides fish for tastings and kitchen experiences for students and other interested parties	Large investment in establishment and running costs Large investment of resources in running and maintenance Possibly viewed as a local activity and not national / regional
Opportunities	**Threats**
Permanent anchor in educational and training sector Basis for inspiration for future business development Basis for capacity building and knowledge hub of RAS aquaculture in the local region	Risk of delays in establishing the facility Risk of failure to inspire stakeholders to engage

Proposal 2: PR Campaign for communication of RAS

Figure 4: SWOT Analysis of PR Campaign

Strengths	Weaknesses
Less investment of time and money in establishing and running a physical pilot	No physical visuals as inspiration Theoretical information No "homegrown" fish for tastings No local practical capacity building
Opportunities	**Threats**
Wider reach on national and regional Baltic Sea level	Competition with other PR campaigns for awareness Too little impact and not enough to inspire new local value chains Risk of failure to inspire stakeholders to engage

Conclusion

The alternative which will be piloted is solution 1: Physical demonstration pilot for communication and social awareness-raising.

Although the investment required both on the personnel and financial levels are elevated, the presence of a physical demonstration pilot for the purposes of interaction has much more potential to be a strong motivator and basis for communication and social awareness-raising than that of a regular PR campaign for RAS aquaculture.

It is of course a risk that the physical pilot can be delayed or will fail to inspire the target groups of future aquaculture stakeholders.

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