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GAIN

Green Aquaculture Intensification in Europe

Grant Agreement Number 773330

GAIN D6.8

Evaluation of the Affiliate Farm Programme and legacy exploitation plan

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Summary

GAIN is an EU-funded research project that brings together partners from academia, industry and associations with the primary aim of supporting ecological intensification of aquaculture in the European Union (EU) and the European Economic Area (EEA). The core focus of GAIN is to increase production and competitiveness of the industry, while ensuring sustainability and compliance with EU regulations on food safety and the environment.

The GAIN Affiliate Farm Programme (AFP) is a dissemination plan designed for GAIN's industry facing tools. The key objective of the AFP is to promote GAIN products to aquaculture farms external to the project, present and install the relevant products to each farm and guide them and the use and optimization of those, to the benefit of the farmer.

The Information Management System (IMS) developed in GAIN is supported by a number of technological solutions that promote the eco-intensification and the implementation of precision aquaculture. These tools are part of the industry-facing side of GAIN:

- AquaPRIME is a sustainable precision aquaculture smartphone app that returns instant growth performance information to the farmer;
- AquaSense is a platform that helps farmers grow fish and shellfish better, giving them the ability to use state-of-the-art mathematical growth models (tool further described in D4.7 and D6.6);
- AQUARADAR is a farm monitoring and modelling service which gathers updated environmental parameters useful for farmers to monitor the growth of their animals (tool further described in D4.7 and D6.6).

This report details the approach used in GAIN to co-opt farms into the AFP, which used as one of vehicles the AquaPRIME precision aquaculture tool, also described here.

Finally a number of ongoing and future initiatives are described as part of the GAIN legacy plan.

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Affiliate Farm Program

The GAIN partnership includes a number of industry partners and end-users, essential in the development and testing phases of GAIN products and innovations.

The IMS and its components, such as the models running on the AquaSense platform, as well as AquaPRIME and AQUARADAR, were key elements in the AFP.

In order to expand the reach of this system, the Affiliate Farm Programme (AFP) for both finfish and shellfish farms was promoted and developed in order to illustrate the benefits of precision aquaculture and scale the GAIN tools across the industry as part of the GAIN legacy.

The extensive networking capacity that exists in the GAIN partnership, both bilateral and through industry associations, insurance contacts, etc, was a key element to achieve this goal—this action was made considerably more difficult by the pandemic and ensuing lockdowns and travel bans that impeded critical presential contacts. The implementation of the AFP leveraged data collection at farms, while establishing the initial stage that ensures a legacy for the European aquaculture industry. However, due to the COVID-related challenges referred above, onboarding of new farms into the AFP had to be done mainly at the local level. We hope that in the coming year, the GAIN legacy plan can benefit from travel opportunities and presential interactions with industry.

Farmers within the AFP either supported the installation of sensors or linked their sensor arrays to the GAIN tools. Their incentive was to gain access to the Big Data management system and to other tools such as AquaSense that help to implement the precision aquaculture model, refined and developed within GAIN, and improve their management and culture practices.

GAIN established contacts with potential AFP participants to present the project products and solutions and help implement and test the connections to the components.

The modelling platform AquaSense, a key public-facing part of the IMS, was one of the tools promoted in these initiatives. AquaPRIME, which offers sustainable precision aquaculture with a negligible investment from farmers was other of the tools promoted in these contacts with the industry.

GAIN Products

AquaSense and AQUARADAR were developed and tested in GAIN's previous work packages, and more details on development and dissemination can be found in D4.7 and D6.6.

The section below briefly describes the development, features and functionalities of AquaPRIME. It also details some dissemination efforts, as well as examples of data obtained by farmers use of the app.

AquaPRIME

One of GAIN's ambitions was the development of precision aquaculture tools for management of shellfish and finfish farms. In order to implement these tools in the EU, they

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need to be able to bridge not only the technology gap that exists in some aquaculture sectors, characterized by small-scale farms, but also the reduced financial investment characteristics of these stakeholders.

In order to be successfully disseminated within the aquaculture sector, AquaPRIME was developed to be a simple tool that would be accessible *in situ* via a smartphone application. By making use of the GPS feature and web connection of smartphones, farmers can insert simple information on husbandry, and obtain a correlation between these and environmental data from mathematical models, including operational weather models, obtained via web API.

By combining these two elements, AquaPRIME, when widely used, can also aid in reducing the current lack of reliable environmental and growth data on the aquaculture sector. Information inserted by farmers can help in improving the current datasets used for policy making and improve other precision aquaculture tools, such as models that simulate biomass production, environmental externalities, and financial performance.

Figure 1. AquaPRIME map and farm selection screen example.

Features and functionality

At its core, AquaPRIME stores growth and mortality data inserted by farmers. The application utilizes the GPS signal of the user smartphone, and each time the farmer inserts data, the GPS records the environmental parameters for that location, at the time of the data input, via a web API. This way, every time farmers insert data, they grow their knowledge on husbandry, by accompanying the growth and mortality of the animals, and see how different environmental conditions impact their farms over time.

The 3-level access of AquaPRIME allows owners to attribute different farms and supervising levels to its collaborators: owner, manager and operator. Managers can be assigned to any number of farms by owners, and a manager can supervise and assign operators between the farms he/she supervises. In essence, one company can have any number of farms, supervised by any number of managers, which in turn assign any number of operators to their managed farms.

A user's only requirements for using the application correctly are an android smartphone with internet access and GPS. Other items required are a scale for weighing the animals and a tray

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to count them. Since the use of the application comes at no cost, farmer investment to have access to growth, mortality and location and time-stamped environmental parameters, is very low, and accessible to almost all shellfish and finfish farmers in the EU and across the globe.

After installation and creating an account, the first step is to establish a company by filling in four fields. After this, the user creates their first farm. By making use of the smartphone GPS, users should make the initial set up as close to the farm as possible, so as to give the most precise location possible. This will be key in order to provide accurate environmental data on the location where the animals grow.

Users should be able to introduce all required information, by following a few steps, with just a few taps on the smartphone:

1. Count the number of live and dead animals and enter data into the app;

2. Count and weigh a number of animals and enter data into the app.

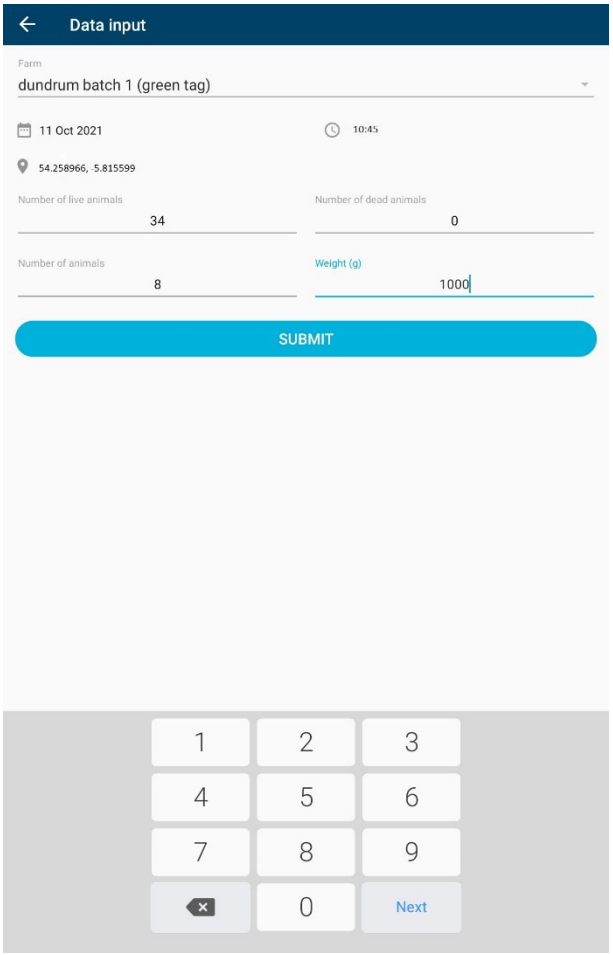

Figure 2. Data input screen example.

The notifications built into the app also allow operators, managers and owners to receive an alert on their smartphone any time new data is inserted, allowing for a quick response to any issues that may arise.

All data entered by users is stored on the backend site (https://aquaprime.tech/) and can be accessed by all users. Each user can access the backend with the same login used for the Android app. The database model replicates the different access levels for each site and each operator, hence each user can only access data on farms he is assigned to.

The backend site also allows users to download their data, so they can use it for their own purposes, which also makes AquaPRIME a tool for data collection.

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Results and stakeholder networking

Once the first stable version of AquaPRIME was completed, activities of presenting the tool to farmers were developed.

In collaboration with GAIN partner SGM, the application was presented and installed for use in Finisterra, a Mediterranean mussel farm company in the south of Portugal. GAIN partner AFBI also met with farm workers at Dundrum in the summer of 2020 and provided a demonstration of the app and data load process.

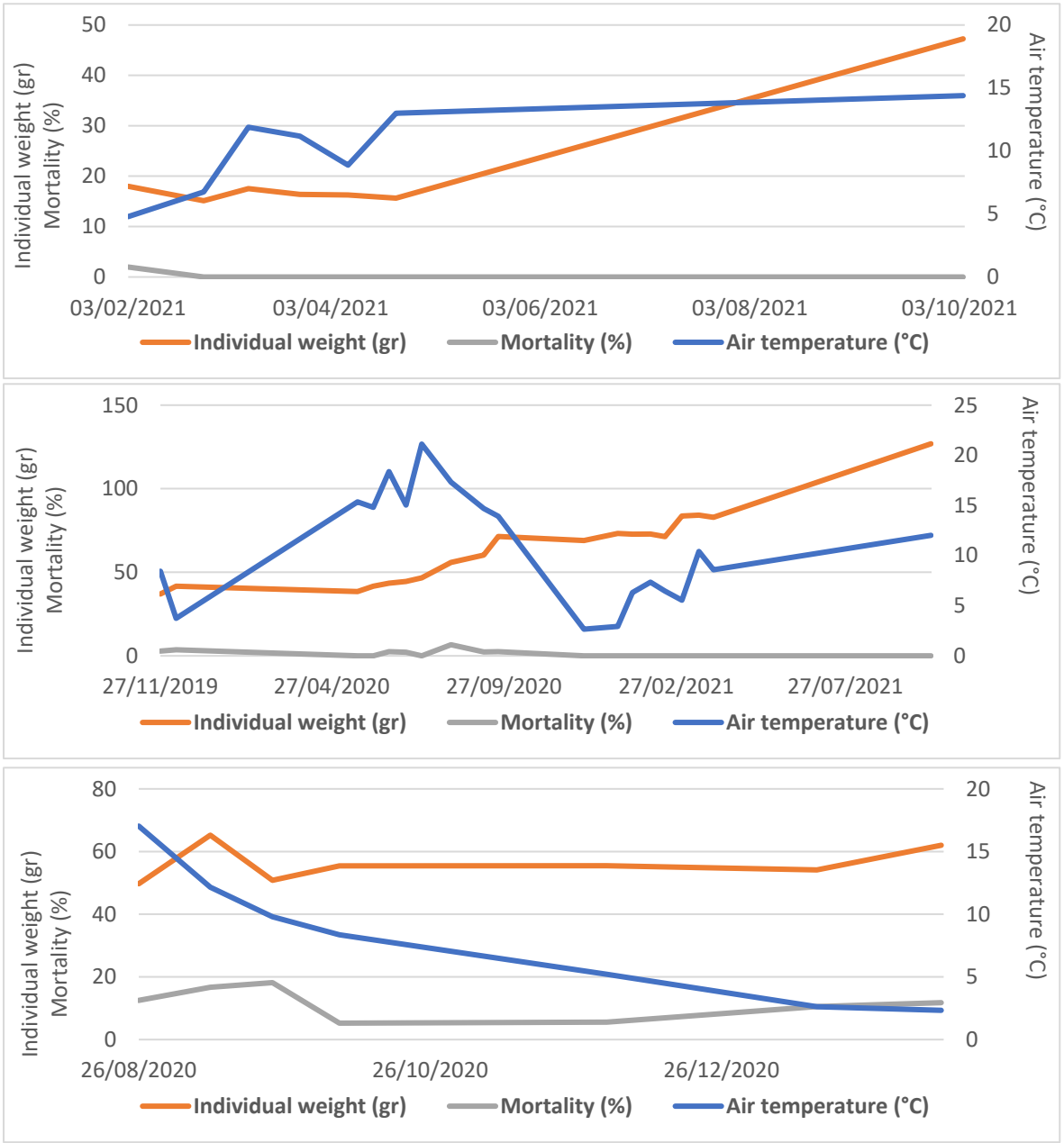

Figure 3. Examples of data uploaded to the database by users. The first and second graphs from above represent two Pacific oyster farms from the DOMA company in Dundrum Bay, Northern Ireland, part of the Affiliate Farm Programme.

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Shellfish growth and mortality data has been uploaded using AquaPRIME since 2019, with some gaps due to COVID-19 related restrictions to farm work and site access.

The connections to stakeholders allowed the improvement of the application, backend and algorithm. One example of that is the possibility to download data, which was an input from an end-user.

AquaPRIME fulfils the objective of bridging the technology gap that persists in small scale farming operations. It enables farmers to load information about their practices and returns simple and easy to access environmental data that allows them to act and better understand the impacts of environmental parameters in their animal's growth and mortality.

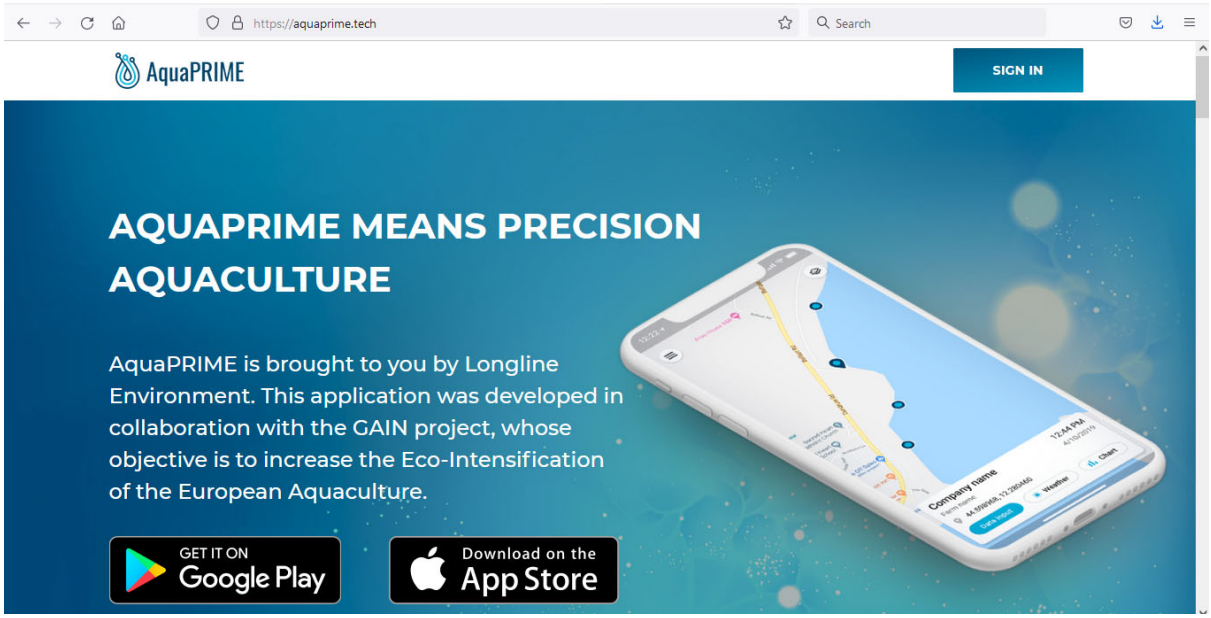

Figure 4. Landing page for the AquaPrime website and portal for company-level cloud data management.

In addition, AquaPRIME also accomplishes a step forward in animal welfare aims. For bivalves, the animals weighed for data inputs in the app, are not harmed and continue to grow, which is a positive for the farmer, and for sustainability.

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The https://aquaprime.tech website (Figure 4) was developed as the cloud backend of the application and includes a landing page to inform potential candidates to the AFP.

A brochure (Figure 5) was also prepared in order to disseminate the AquaPrime application to farmers, but the total absence of industry-relevant opportunities to share the concept and elaborate on the merits of using the app to enhance precision aquaculture severely limited the scope of what could be achieved. In 2021, an effort was made to develop a more feature-rich version of AquaPrime based on user feedback, with the intent of broadening the appeal to a struggling industry, preoccupied with many other operational aspects at this very difficult time.

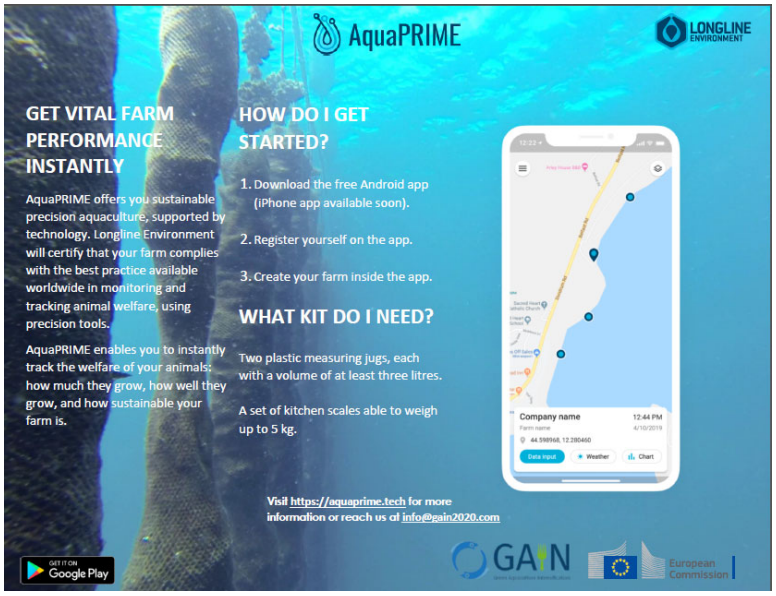

Figure 5. AquaPrime brochure for dissemination to potential AFP partners.

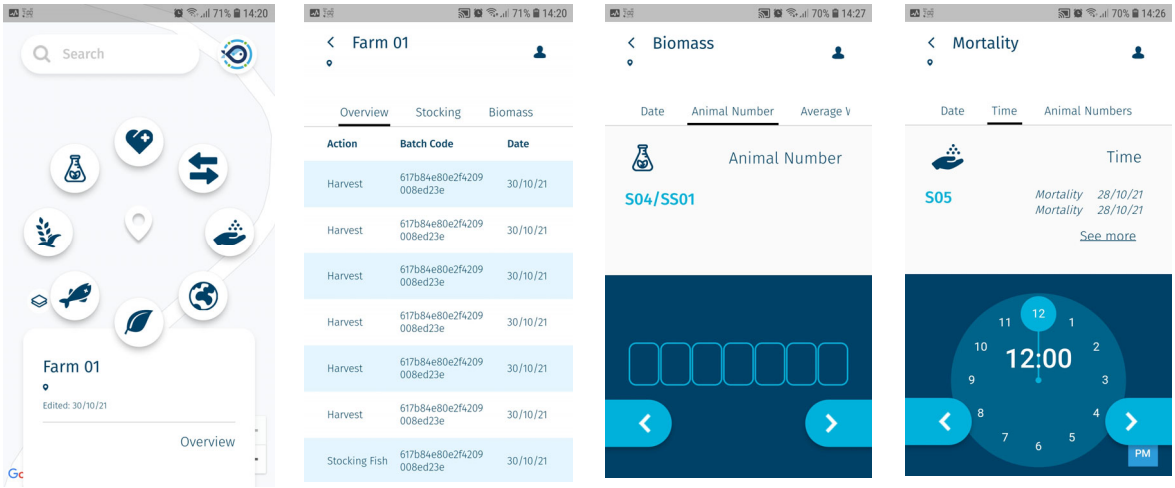

Figure 6. AquaPrime beta version with a completely updated interface and user flow (UI/UX).

GAIN partners are committed to continue the development post-GAIN to help the AFP expand and thrive. Figure 6 illustrates part of the beta version of the updated application. This has only been tested internally in the project; it will be rolled out to AFP partners for field tests after the end of GAIN, and development will be supported by complementary funding sources as part of the legacy plan.

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Affiliate Farm Programme initiatives and engagement

The efforts to gather participant farms and companies for the AFP focused on presenting the tools and applications with collaboration from GAIN partners. We able to bring into the AFP four different farms, covering both shellfish (mussels and oysters) and finfish (seabass, gilthead bream, and rainbow trout), from Italy, Portugal, and the UK (Northern Ireland).

Doma Northern Ireland

AFBI presented the application to shellfish farmers who operate in Northern Ireland (NI), as part of their work with mussel and oyster producers in the context of GAIN. An interest in AquaPRIME was expressed by a number of farmers.

Data gathering and use of the application initiated in 2019, with participation from AFBI for initial tutoring and explaining of the platform to farmers as well as for improving and refining further versions of AquaPRIME taking into account user feedback.

GAIN staff from Longline Environment (LLE) travelled to NI in 2019 to meet a farm manager from DOMA NI, an oyster and mussel farm that is part of the French Famille Boutrais Group (https://www.lafamilleboutrais.com/), and excellent example of a forward-looking company that also sell oysters online. LLE installed the application for use by the company, which operates in inner Dundrum Bay. The Pacific oysters farmed on the Dundrum site are grown to market size from half-grown and shipped to France. DOMA.

Finisterra, SW Portugal

The initial contacts with Finisterra S.A, a Mediterranean mussel farming operation with a production of about three thousand tonnes at an offshore site in southwest Portugal, were established by GAIN partner Sagremarisco (SGM).

Finisterra farms and processes its mussels with or without shell, with varied processing and presentation from 60/80 to 220/300 sizes on 1kg to 10kg packaging. Their Mediterranean mussels are organic and bear the ASC (Aquaculture Sustainable Certification) label. Finisterra was linked to the IMS and the AquaSense platform, using their own sensor array. The Portuguese sensor company Sensaway that operates their sensors was part of our effort in order to successfully implement within the existing sensors the capability to upload the data to the IMS server and make it available for use on the AquaSense platform.

AquaPRIME was also presented to Finisterra in two occasions, with SGM being integral to the approach. In 2019 the first presentation of the application was made, and after improvement of the app upon suggestion to make it more appealing and easier to use for mussel farmers, installation was provided in a meeting between LLE, SGM and Finisterra SA in 2021. The company is currently using AquaPRIME.

Viveiros da Espargueira

Viveiros da Espargueira SA is a company whose activity is sustainable aquaculture of gilthead bream and seabass in the natural reserve of Ria de Alvor, Algarve, Portugal. Viveiros da Espargueira focuses on using the latest technology to improve fish production, keeping a high level of control of the entire production system.

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Contacts have been developed by LLE to promote the use of AquaSense in this company by means of a collaboration with Sensaway, which operates the sensors at this farm via its BlueEdge platform.

Figure 7. Viveiros da Espargueira, a bass and bream AFP site in southern Portugal.

Both Sensaway and the BlueEdge platform are part of the successful integration of the AquaSense IMS tool and are an example of the capacity of the GAIN partnership and products to provide solutions to farmers, built upon their existing infrastructure, platforms and processes, while integrating other actors.

Troticoltura Leonardi

Troticoltura Leonardi is a family-run company in Northern Italy, specialized in rainbow trout farming. UNIVE met with this company to present the results, via the data exploitation from one of their sites. The company demonstrated great interest for the work done using the data recorded at its Preore premises and made available through AquaRADAR platform.

The services that particularly interested this AFP member were:

- The real-time visualisation of temperature and Dissolved Oxygen (DO) data, as it allows them to have a quick and updated overview of the farm situation in a functional way (in terms of raceways and not only one probe after the other);
- The smart control of oxygen supply, as the farm manager realized that with little investment it would be possible to improve the distribution of liquid oxygen and thus improve economic and environmental sustainability;
- The feed optimization based on the population model. Even if results need to be further confirmed, the first outcomes are promising and, as feed is the main cost for land-based aquaculture, the end-user was particularly interested in trying to use the model predictions in terms of feed quantity to be supplied.

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Next steps are the extension of AquaRADAR services to the two other Leonardi production sites and the implementation of a control loop for oxygen supply.

Coldiretti

Coldiretti (Confederazione Nazionale Coltivatori Diretti) is one of the main associations of agriculture entrepreneurs in Italy. GAIN main outcomes were presented to a panel of more than 20 farmers or farm managers who were interested in implementing ecological intensification of their activities.

The GAIN innovations presented focused on precision aquaculture solutions for marine and land-based farming, namely the AquaSense and AquaRADAR nodes. There was also an interest in the sustainability assessment of production processes through the LCA methodology.

Feedbacks were positive, and there is the possibility that a number of these participants could be interested in further use of the GAIN project solutions.

Associazione Piscicoltori Italiani

The Associazione Piscicoltori Italiani (API) is the main association of fish farmers in Italy. Within the frame of the webinar conducted, the main achievements of the GAIN project were detailed with particular focus on production related tools that can help implementing the ecological intensification of aquaculture.

The IMS approach, particularly the AquaSense and AquaRADAR platforms, were presented. These platform and the connected web services were detailed to show how they could support farmers daily decision processes.

The first comments were positive and show that GAIN achievements could be of interest for aquaculture managers.

AQUAFARM

AQUAFARM is an annual international conference & trade show dedicated to aquaculture, algaculture and fishing industry. It is a key event for the aquaculture sector.

In the 2020 edition, GAIN presented its activities through a dedicated stand that was visited by many professionals of the sector.

Furthermore, GAIN coordinator was invited to present GAIN objectives and achievements in a conference session dedicated to innovative contributions that aims improving production systems.

The contacts and interest collected during this presentation can be of value to the legacy and future dissemination of GAIN products.

Legacy plan

The AFP legacy plan is composed of the initiatives mentioned previously, which are summarised in Table 1, and by three complementary activities, described below: AquaPet, the FAO Regional Platform and the IBM-driven YieldLab Asia Global Aquaculture Challenge.

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GAIN products

Software platforms

Table 1 shows various legacy programmes associated with software that contributes to a paradigm shift in aquaculture management. These actions have guaranteed commitment by partners, including LLE, AFBI, UNIVE, and associated enterprises such as the UNIVE spinoff BlueFarm. The current trends towards a more generalised use of cheap sensors, together with present-day concerns regarding emissions, climate change, and locally sourced foods indicate that this legacy strategy is not only the right approach, but can be largely auto-financed, and is very much within the remit of the SME's involved.

Table 1. Summary of GAIN legacy initiatives

Topic	Purpose	Vehicle
Farm management and traceability	Increase industry onboarding of technical tools, capacity building	Further development and testing of the AquaPrime application, final rollout
Precision aquaculture	Increase connectivity between farm and digital diagnostic and prognostic tools	Leverage the use of AquaPrime and presential contacts to drive increased use of AquaSense, AQUARADAR (both described in D4.7 and D6.6), and other parts of the IMS (see D1.89
Consumer proximity and transparency	Promote awareness and usage of the GoodFish B2C app	Placement of GoodFish (see D6.5) in key retailers, including high-end supermarkets, restaurants, and online platform
Supply chain dynamics	Shorten the supply chain for cultivated seafood (and potentially wild-caught species)	Promotion of the SailFish platform (see D6.5) to encourage end or near-end members of the supply chain to interact
Framework for eco-intensification	Provide a multi-actor, transdisciplinary hub for integrating the various GAIN tools listed	Improve the connectivity between the various tools (AquaPrime, AquaSense/AQUARADAR, GoodFish, SailFish) as appropriate, allowing industry to leverage e.g. their use of the B2B platform to better manage their farms on AquaPrime, going some way towards precision aquaculture, and then providing an onboarding route to AquaSense, which provides further business intelligence for better food production

Secondary products

The AquaPet deliverable, included and fully described in D6.9, provides the exploitation blueprint for use of PHHP 75, or Partially hydrolysed high-protein with a protein content of 75% or over.

The legacy plan for secondary products includes other aspects such as shell re-use and nutrient credit trading, which are beyond the scope of this text, but AquaPet can be developed as a company initiative based on a business case included in the report, which includes costs, depreciation, break-even points, and the other aspects typical of financing a new enterprise. The AFP is a vehicle for dealing with raw material sourcing for offcuts, which would be the basis for producing pet food ingredients, potentially tapping into up to 40% of 415,000 tonnes of bass (≈221 kt) and bream (≈194 kt) farmed annually in the Mediterranean.

FAO Regional Platform

The RTP-AQ is envisioned to be a dynamic and interactive platform serving the needs of multiple stakeholders including FAO offices, governments, farmer organizations, financiers,

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researchers, private sector, CSOs, etc. The platform will include (but not be limited to) webinars and workshops to connect experts with those seeking support; and a web-based space listing events, publications and training opportunities. The RTP-AQ aims to improve access to information from a wide range of sources and provide forums for dialogue between experts and stakeholders to share knowledge, perspectives and experiences, and to develop and finance new projects.

The platform should open up global opportunities to share best practice and innovation and develop networks both regionally and internationally, including increasing the opportunities for south-south collaboration. GAIN partners have been invited to include innovation case studies into the platform on an on-going basis. Two cases were identified: the contributions will be delivered to the FAO RP-AQ by the end of March 2022.

The ecological intensification of pond carp farming, by coupling ponds with recirculating aquaponic systems for carp wintering: GAIN results indicate that this innovation could lead to shorten carp grow-out cycles from 33 to 19 months.

Novel sustainable feed formulations, based on ingredients from circular processes and emerging ingredients, i.e. micro- and macro-algae, insects.

Global Aquaculture Challenge (https://developer.ibm.com/startups/startup-partner/)

A continuous goal of the GAIN project – as evidenced by the Affiliate Farm Programme – was extending the reach of the project beyond the parties involved in the consortium. One opportunity we exploited was engagement with an accelerator program for aquaculture start-ups facilitated by The Yield Lab Asia (part of The Yield Lab global network of Venture Capital funds and Accelerator programs), called The Global Aquaculture Challenge (GAC). GAC offered eight innovators the chance to participate in a non-residential and non-dilutive accelerator program. Successful applicants were provided with relevant subject-matter expert mentoring and exposure in front of potential investors to win cash and other prizes at the final pitch.

IBM were the technology partner for the GAC and served as a bridge between the GAIN project and the start-ups involved. While at a fundamental level IBM technology was made available to the participating start-ups, we also offered significant technical and scientific expertise related to aquaculture industry innovations. GAIN participants served as mentors and strategic advisors for the cohort. We communicated our experience from the GAIN project in a series of workshops involving the start-ups and other mentors and strategic advisors (including key members from the aquaculture scientific and business community) throughout the accelerator program. This was a valuable opportunity to both engage with the start-up ecosystem and extend the reach of the GAIN project. IBM have developed a close collaboration with one of the cohort -- WittayaAqua – and will apply models developed within the GAIN project to another pilot site in Vietnam.

Building on this successful engagement, The Yield Lab Asia have been onboarded as an IBM "startup partner". This means that all companies in The Yield Lab portfolio are enrolled in the "Startup with IBM" program. This gives them up to $120,000 in IBM cloud and AI credits that

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they can use to build and expand their aquaculture innovations. Since the core GAIN IMS is built on IBM cloud (using IBM tools such as Watson Studio, AutoAI, Cloud Pak For Data), we can make the GAIN IMS available to startups in a streamlined manner (at no cost). We already used this approach with Wittaya Aqua – we applied models developed during GAIN to Wittaya Aqua datasets, and demonstrated cloud-based integrations of those models with in-house models owned by Wittaya. This allows interested startups to valorise innovation developed during GAIN within their own offerings and extend these with a suite of IBM cloud and AI products and services. Discussions are ongoing with other startups in The Yield Lab Asia portfolio about how IBM cloud and AI credits can be used to accelerate development and a core part of that conversation is how GAIN models can be leveraged.

Conclusions

This report summarised the GAIN consortium's evaluation of the Affiliate Farm Programme (AFP). This evaluation includes the positive points and inevitably also the serious challenges faced due to the COVID-19 pandemic and ensuing lockdowns and travel bans.

Overall, we believe that the AFP has demonstrated its potential for industry acceptance, despite the adverse conditions, and we are confident that what we have achieved so far will be leveraged over the coming year.

We have a strong legacy plan in place to achieve this goal, not only in terms of the suite of industry-friendly tools we produced, a number at higher Technology Readiness Level that expected at the start of GAIN, but also in terms of the critical aspect of funding these legacy actions.

The strong commitment of SMEs to this legacy plan is an added assurance of success. In parallel, other initiatives such as the FAO regional platform will help promote near-market project outcomes, and we believe that collectively, GAIN has produced a set of industry-relevant tools that can contribute to a paradigm shift towards eco-intensification of European aquaculture.

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