



Norwegian Lobster Farm's patented 3D technology for crustacean farming

INNOVATIONS IN LAND-BASED RECIRCULATING AQUACULTURE SYSTEMS TO PRODUCE MARKET SIZED EUROPEAN LOBSTER IN NORWAY

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European lobster (*Homarus gammarus* L.) is one of the most valued seafood in the world and has a global market. It is also a relatively easy species to rear in aquaculture and the lobster biology is fairly well understood. The main limitation for lobster aquaculture has been high production costs due to the demand for 18-22°C water to get acceptable growth rates, and the need for individual rearing compartments to avoid cannibalism and uneven growth rates due to hierarchies. Also, the lack of a high quality formulated feed has been a limiting factor. However, during the last decade rising prizes of lobster and development of new recirculation technology have again made lobster a promising candidate for “closed cycle” aquaculture. In addition, a new law in Norway ensuring property rights for sea-ranched lobsters has promoted an opportunity to mass-produce lobster juveniles for sea ranching purposes.

The only operating plate sized lobster factory in the world is located on the island of Kvitsøy in south-western Norway (Figure 1).



Figure 1. Norwegian Lobster Farm established the world's first commercial production of plate sized lobster in 2007.

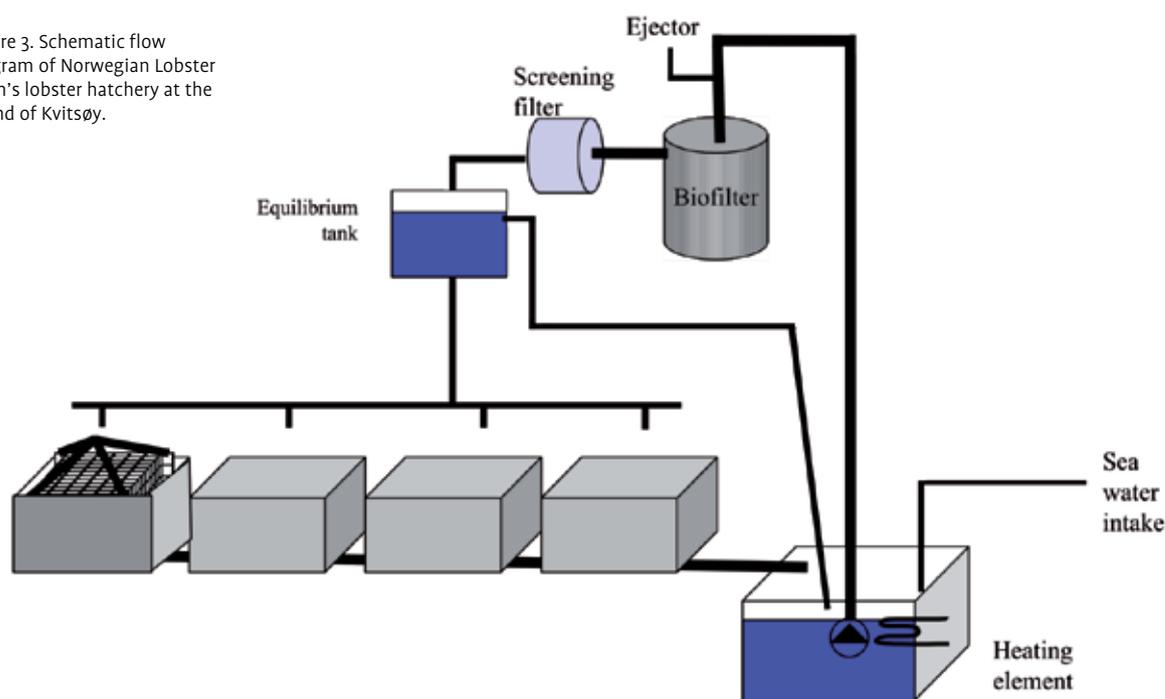
In 2000, a major R&D project was initiated by the company Norwegian Lobster Farm with the aim to evaluate the potential for commercial production of plate-sized lobsters (20cm/300g; Figure 2).

All trials were conducted in small to medium scale in order to reveal and solve the main bottlenecks (biological, technical and market challenges) before commercialising. Moreover, Norwegian Lobster Farm has a separate hatchery where IV-stage juveniles are produced from brood-stock carefully selected from vital farming criteria. A schematic layout of the lobster hatchery is shown in Figure 3.



Figure 2. Plate sized lobster produced by Norwegian Lobster Farm.

Figure 3. Schematic flow diagram of Norwegian Lobster Farm's lobster hatchery at the island of Kvitsøy.



TECHNOLOGY

The ideal system for rearing lobsters individually should be relatively inexpensive to construct and operate; simple to maintain; based on automatic feeding and self-cleaning of tank and cages; maintain ideal water quality conditions; use space in three dimensions; enable high densities; conserve water at high temperatures; ensure good survival and permit easy access to the livestock for inspection and feeding.

American researchers reported in 1995 that no successful attempts had been made which includes all of these features into a single design. Until the year 2000, neither commercial nor R&D activities have been done in Norway to develop a land-based farming concept for raising plate-sized lobsters. During the last eight years, the Norwegian Lobster Farm has developed, tested and documented six different technologies (i.e. single trays, stacks of trays, horizontal as well as vertical car-o-cells, strings of polyethylene and communal rearing). The aim of the project was to develop cost-effective farming

solutions using recirculation of heated seawater (Figure 4).

As a result of this work, Norwegian Lobster Farm has patented a new farming technology in 23 countries that incorporates all necessary prerequisites for successful and profitable culture of plate sized lobsters. This technology lifts the crustacean industry from 2D to 3D by effectively utilising all three dimensions in the water column (Figures 5 (intro) and 6).

Moreover, the company has developed all automated technologies that now supplement most of the procedures that previously were dependent on manual labour. The concept includes the use of selection robots (classification of larval stages), feeding robots, harvesting robots, remote desktop solutions and image processing software to identify moults, mortality and the time for harvesting (Figures 7, 8 and 9). The farming concept has been successfully tested over the last three years. The company is now commercialising the results, and plans to expand their production up to 20 MT annually in a new factory on the island of Kvitsøy.

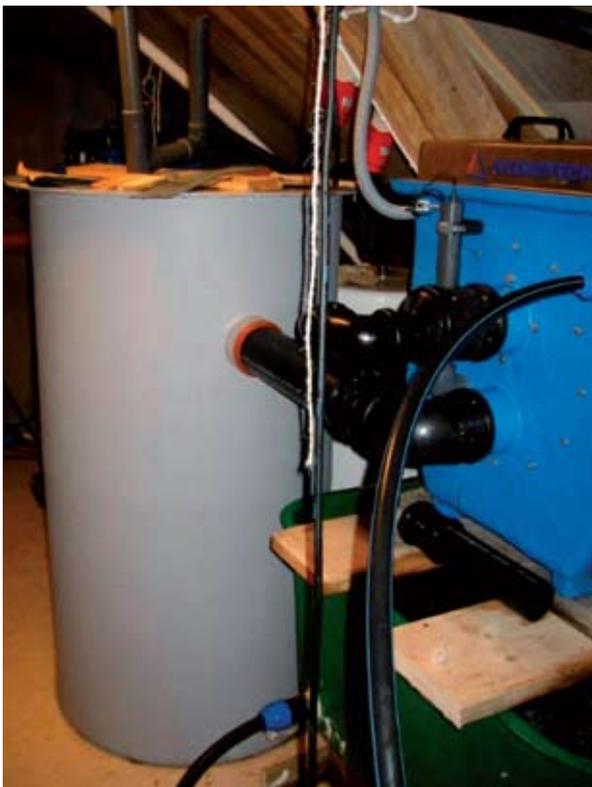


Figure 4 (above). Moving bed biofilter installed the recirculating aquaculture system RAS to Norwegian Lobster Farm



Figure 6. Norwegian Lobster Farm's patented 3D technology for crustacean farming

FEED

Norwegian Lobster Farm has also developed a new formulated feed especially engineered for the European lobster (Table 1; Figure 10).

Table 1. Chemical composition and nutritional content of the feed (% of dry matter).

Nutritional content	%
Protein	54.7
Lipid	15.6
Carbohydrates	13.6
Ash	9.5
Water	6.8
Energy (MJ/kg)	21.6

In the initial trials with commercial formulated diets, all lobsters were fed with ordinary cod feed (DanaFeed). As a result, most lobsters had pale pigmentation due to a lack of pigment in this feed. It was therefore easy to observe the changes that occurred in colour and thickness of the shell after introducing the new lobster feed. Already after the first and second moulting there were significant and homogenous changes in pigmentation, where all lobsters slightly turned from white to light/dark blue and finally to black (Figure 11).

Norwegian Lobster Farm has now produced plate-sized lobsters solely on a formulated diet (including the larval stages) for 4 years. No one has previously reared lobsters from metamorphosis to commercial size in 2-3 years solely, or even largely, on a compounded diet. The feed conversion ration (FCR) has been calculated for the new diet employed and was within the range 1.20 – 1.34 kg/kg weight gain.

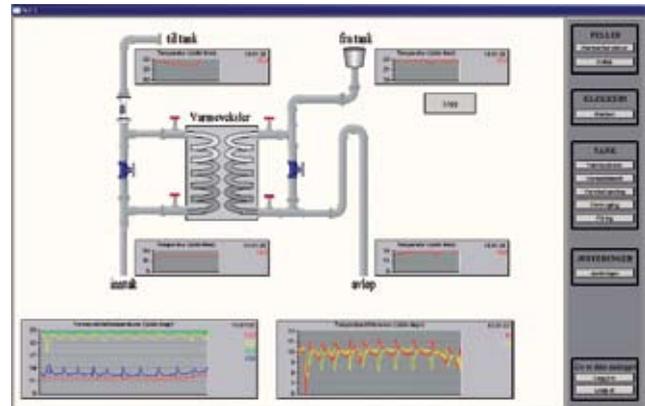
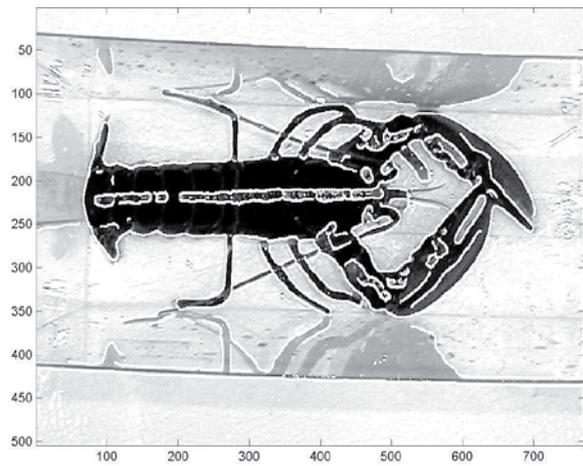
WATER QUALITY

Desirable levels of water quality for clawed lobsters are temperature of 18 - 22°C, salinity of 28 – 35 ppt, above 6 mg oxygen/L (70% saturation), pH of 7.8 – 8.2 and less than 14 µg N/L as un-ionised ammonia. For short periods, lobster will tolerate considerably lower oxygen and higher ammonia concentrations than indicated as desirable levels. Ammonia concentration is the most limiting parameter in recirculation systems for seawater. Norwegian Lobster Farm's hatchery, the biofilter is efficiently removing total ammonia (TAN) at rates of 50 – 70% depending on biomass load versus the biofilter's capacity was utilised.. In initial tests, concentrations of un-ionised ammonia in the tanks were in the range 0 – 5 µg N/L. Lobster feed is high in protein and the ammonia excretion rates in the animals are correspondingly high – average rates of 0.1 – 0.5 g TAN/kg/day has been reported for adult lobster.

Currently there is still a lack of sufficient knowledge on respiration and excretion rates for lobster at all stages. Based on the economic importance of these issues, Norwegian Lobster Farm is currently addressing revealing recommended values for all critical water quality



Figures 7, 8 (above), 9 (below left). Automated solutions for cost/effective landbased RAS farming



Remote desktop solution developed by Norwegian Lobster Farm



Figure 10. Pelleted feed formulated by Norwegian Lobster Farm

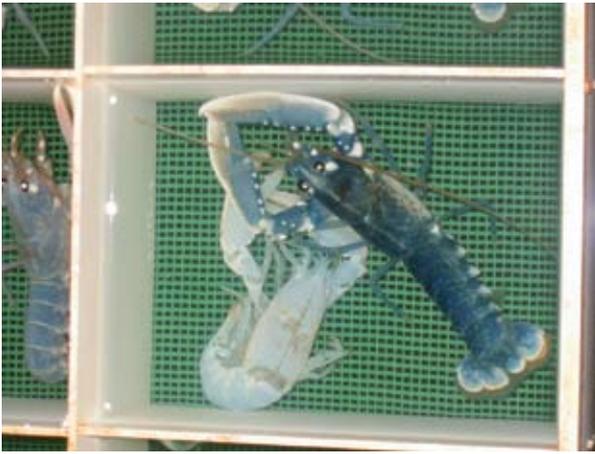


Figure 11. Colour change after first moult with Norwegian Lobster Farm's diet



Figure 12. Test panel at the Culinary Institute of Stavanger evaluating colour, texture, taste and overall impression of Norwegian Lobster Farm's plate sized lobster

parameters to be used for dimensioning of technical equipment and in order to sustain a healthy environment for the biomass.

CULINARY TESTS

The plate sized lobster produced at Norwegian Lobster Farms factory has been tested several times at the Culinary Institute in Stavanger, Norway (Figure 12).

In these tests the farmed product was rated higher than wild caught lobsters, and gave promising results for introducing this high quality product into the high-end market segments.

FUTURE PLANS

The first commercial scale module at Kvitsøy has the capacity to produce around three metric tons (MT) annually. This capacity will be increased to around 20 MT and then to 70 MT within a few years. Since the system is module based, commercial units producing 10 MT annually have been developed making it possible for the farm to expand stepwise by building up their biomass capacity according to the needs.

In order to successfully develop the company into the industrial stage, Norwegian Lobster Farm is now seeking strategic partners and investors to take part in this new industrial adventure.

Further information:

www.norwegian-lobster-farm.com

www.hobas.no

Scottish Aquaculture Research Forum



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