The Offshore Aqua Cage --
"Proven Dependability"

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Introduction

Atlantic Aqua Marine, Inc. is a subsidiary of the
Armstrong Group. It:
• has been involved in all aspects of fish farming
over the past 13 years.
• has designed and constructed two of the largest
fish ladders in New Brunswick and worked on
several others.
• has supplied equipment which has been tested in
"active fish farm operations" in the harshest condi-
tions in Atlantic Canada.
• has and continues to produce the Aqua Truck -- a
multi-task work vessel serving the aquaculture
and other marine industries.

Among the services offered is a complete turn-key
operation including:
• Site analysis.
• Cage supply.
• Anchor and attachment supply and
installation.
• Net supply and installation.
• Training.
• Maintenance and inspection.
• Operations management.

Optional equipment can be supplied including:
• Automatic feeding.
• Net weaving.
• Barges (powered or unpowered).

Background
Developed in 1985 and no longer in production, a total of 235 of our earlier model cages were built. The majority were deployed in the Bay of Fundy area of Atlantic Canada.

This system offered:
• Galvanized steel construction 12 and 15 meter available.
• Sections connected with stainless steel hinge posts.
• A center walkway of plus/minus 2 meters width with research walkways.
• Foam filled doors provided buoyancy.

Offshore aquaculture in Penobscot and Bay

Considerations:
• Shortage of isolated protected sites.
• Availability of larger sites.
• Cleaner water and better fish nurturing conditions.

Problems:
• Extreme northwesterly winds often reaching 70 knots.
• A six mile fetch.
• A deadly shot chop reaching 12 feet in height.
• Four-hour tides.
• Heavy fix buildup from breaking spray during winter months.

Solution
• The Offshore Octagon Cage System.
• Rugged simplicity of a steel ship-like structure.
• Four cages for culture of salmon have been in the water for three winters in the lower end of Penobscot Bay.

Cage Construction
Major features include:
• Innovative design and rugged large diameter 36 to 48 inches – 0.9 to 1.2 meter steel pipe construction able to withstand a wide variety of weather conditions.
• Weight (30,000 to 40,000 lbs) and rigidity allow for minimal movement in rough conditions.
• 25 meter diameter offers great stability even in storm conditions.
• Life expectancy of 40 years with proper maintenance.
• No moving parts and self floating.
• Ease of assembly and anchoring at location.
• Good access, capable of handling severe ice build-up.
• Safety and stability for personnel with handrail equipped walkway around perimeter.
• Optional ability for lowering below surface to avoid storm conditions.
• Individual or cluster mooring.

Standards
Design and construction of our cages must exceed the following standards:
• A.S.T.M.
• CAN/CSA
• Lloyds of London.
• Safety and stability for personnel with handrail equipped walkway around perimeter.
• Meets or exceeds international standards.
• Ability to grow both bottom fish and fin fish.
• Ease of service and maintenance.
• Affordability and long term value.

Distributed by:

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U.S.A.
Farmocean Offshore System --
The Future is Here

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Good Morning ladies and gentlemen,

It is a great honour for me to be invited to speak to such a distinguished group of people at this conference. Offshore aquaculture represents a new, interesting chapter in the industry. This conference is proof of that development.

Today, I want to talk to you about FARMOEAN INTERNATIONAL AB and their line of offshore semi-submersible systems. On the first slide, we see both a picture of the system and the corporate logo.

I will start by presenting the company and its history. Then, I will show the offshore cages and how they work. We will look at a couple of reference installations around the world. Finally, I will discuss our plans in North America.

NORDITRADE is a firm specializing in developing trade relations between Scandinavian and North American companies. We are based in Toronto. Our relationship with FARMOEAN, which is to introduce their offshore cages on the North American market, started about a year ago.

FARMOEAN INTERNATIONAL AB, based in Göteborg, Sweden, was founded in 1983. It was the result of research activities at the University of
The tests were successful, so FARMOCEAN INTERNATIONAL AB was founded. In 1986, the first FARMOCEAN-Spar® Nomadic Offshore Fish Farming System was launched. To date, more than 40 systems have been installed worldwide. This represents some 130 years of combined production. Most systems are found in Northern Europe and the Mediterranean Sea.

While I am here to talk about FARMOCEAN'S OFFSHORE SYSTEMS, the company is also producing a line of "traditional" circular offshore cages, as is shown here (slide 3). They are marketed under the name POWERFISHING. At some sites, both the infield and offshore cages are installed. Slide 4 shows such a site in Norway.

FARMOCEAN also supplies other related products, such as workboats, servicing systems, feed boosters (slide 5) and computerized feeding systems. The actual manufacturing is normally done by sub-contractors. In addition, the company offers consulting services, such as feasibility studies.
It consists of a tubular galvanized steel structure, mounted on a hexagonal postion. With a total weight of around 20 tons, the steel structure measures 20 metres, or 66 feet, across.

The system is available in four sizes: 2500, 3500, 4500 and 6900 m³. In imperial units this corresponds to 660, 925, 1190, and 1706 gallons.

The depth of the net is 15 m, or 45 feet. The same structure can be used for different sizes, making the nets interchangeable. The production capacity is up to 150 tonnes.

The normal operating position for the system is in a semi-submerged position with the postion three metres (close 10 ft) below the water surface. The upper work platform and the feed are then located roughly three metres above the water.

FARMOCEN's cages are verified by DNV. Off Norway Vertas, 5.5 m waves, 35 m wind, and two knots current simultaneously, all acting in the same direction.

In “real life,” some of the units on the French west coast have experienced waves of 10 m without any major problems. Here, we see a windy site from the Shetland Islands (slide 7).

The net bag is suspended from the inside of the postion and the superstructure. Hanging outside the bottom of the net bag, but attached to it, is a heavy nylon tube. This maintains the shape of the net bag, even in strong currents.

A produce bag can be pulled under with the net bag and attached to the postion. In addition, 12 produ-
The panels can be fixed to the tubular structure between the pontoons and the upper work platform.

A FARMOCLEAN system is equipped with a threepoint lifting mooring system. This mooring arrangement makes it fairly easy to move a FARMOCLEAN system and, if required, it is also possible to move the system and/or mooring to a new site, even with fish in the net.

All FARMOCLEAN offshore systems have, so far, been manufactured in Europe, mainly in Sweden. For the North American market, we are, however, considering to have the units manufactured at least in part on this side of the ocean.

It normally takes circa five days to assemble a FARMOCLEAN system. This excludes the time for installation of the mooring as well as the attaching of the net bag to the structure. These two slides from Sicily show the assembly of a unit (8 and 9).

In addition, slide 10 shows the whole structure.

Mooring plans are prepared by FARMOCLEAN in close contact with the customer, so that the equipment design can be chosen for any particular site.

Slide 11 is from Madeira.

With the reservation that each site has its unique features and requirements, the slides for a FARMOCLEAN system, including similar tube, housing arrangement, feed silo and computer-controlled dispensing mechanism is between SEK 2.0 and 2.5 million, or US$ 280,000 to 370,000. Transportation, mooring, etc., will come on top. In order to provide a firm estimate, FARMOCLEAN normally starts by making a feasibility study looking at the unique characteristics for the proposed site.

Based on years of experience, FARMOCLEAN OFFSHORE systems have proved many times that they can withstand periods of very bad weather without virtually any damage. Installations outside Norway, as was mentioned earlier, have experienced waves of more than 10 metres.

In order to improve the performance of its systems, FARMOCLEAN has worked hard to come up with a specially designed net bag, suspended inside the structure.

As the following slide from Sicily shows, the FARMOCLEAN system is semi-submersible. Therefore, movements will be small even in bad weather.
This will minimize the wear and tear on the net (slide 12). The walker tube will also guarantee that the net holds its shape and prevent it from floating up to the surface. The last movements of the net bag will minimize the risk of fish being caught and drowned trapped by the net.

Fish can be moved from one cage into a FARM-OCEAN system by using either a hand net or a fish pump. In addition, it is possible to attach a transfer tunnel to the FARM-OCEAN system and the transfer cage so that the fish can swim into the cage.

A FARM-OCEAN system (slide 6, p. 11b) is equipped with a feed silo that holds three tons of dry pellets. Feed on the upper work platforms, circa three meters above the surface. At a large percentage of feed is required, a paddle wheel system has been developed for dry feed. This can gently transfer three tons of feed from a service boat to the silo in three quarters of an hour.

Feeding is automatic and computer-controlled with several built-in compensations, such as the temperature, water depth and increased biomass or for achieving maximum growth and minimum feed consumption. However, without a skilled fish farmer who knows his fish well and, based on this, can pre-set a suitable program, the result will not be adequate.

Despite automatic feeding, it is still very important that the fish farmer checks the fish regularly, e.g. once every day just before dawn. Experience shows that the investment in automatic feeding systems will soon be paid back in better growth, reduced feeding costs, better control and more time to do other things.

By using larger and deeper cages, it is harder for the fish farmer to observe fish behaviour and the bottom of the net. Therefore, diver inspections must be carried out more often with large systems. The frame and the net bag can be inspected at the same time.

Many fish farming companies have their own divers, but others have chosen to enter into agreements with professional divers. It is recommended that divers inspect the installations at least once a week.

Dead fish can be collected using a diver. The net bag on the FARM-OCEAN system has a sack in the center that can be opened from the outside. Dead fish will be collected in this sack and can be removed from the outside without stepping on the fish.

The FARM-OCEAN system also has a device for bringing up dead fish without a diver. A dead net can be slid along the center rope, which is attached to the sack ring in the net bag and to the anchor on the feed silo.

However, bringing up dead fish inside the net bag may stress the rest of the fish, reduce their appetite and spread disease. Therefore, FARM-OCEAN recommends that dead fish be removed from the outside.

Fish can be treated for parasites and diseases in basically the same way as in smaller cages. The treatment procedure must be carried out when the weather is good and the current is weak.

A normal like treatment procedure on a FARM-OCEAN system starts with deblading the farm to the service position. The walker tube is then heated up and thus also the net bag. When a suitable volume is reached, depuration of the amount of fish, six to ten percent of the total “active” fish, is carried out inside the net bag. The treatment solution is then either pumped out evenly over the surface or pumped out through a perforated tube.

Recommended stocking should not be greater than 35-50 small per m². This number, of course, depends on the size and type of cage. In general, densities of 50 kg/m² are recommended for most cages and systems.
The fish farmer can either choose to harvest the fish during a short period, e.g. a couple of weeks, or a longer period like a couple of months. The procedure is the same, but the latter is more time-consuming and more stressful for the fish.

In both cases, the best way is to transfer a certain amount of fish from the offshore cage or system into a small cage or cages that are towed to land, where the fish can be stunned and then slaughtered. The three pictures below are views of salmon harvesting in Scotland.

In the FARM-OCEAN SYSTEM, a predator bag and 12 predator panels protect the fish from whatever threatens. Predator nets also give some protection for the nets against floating objects (slide 17).

In order to give FARM-OCEAN systems protection against unsighted predators, the un-manned units can be equipped with alarms. Furthermore, the structure itself is designed so that in some extent reduce the ability of strangers to reach the fish.

To ensure that the water exchange in the net bag is sufficient, it is important to change the net before it becomes too fouled. A clean net for a FARM-OCEAN SYSTEM weighs between 500 and 800 kg, or 1,100 to 1,800 lbs, and may be placed in the water by hand. However, a crane is required when the fouled net is lifted as it may weigh up to 10 times more than a clean net. This is something one must consider when choosing a boat for the operations.

Here, FARM-OCEAN SYSTEMS offer an interesting advantage. By debulking the aris in its service position, which looks like this (slide 18), fouling down to two three meters can be cleaned off. This possibility reduces the number of times the net bag has to be changed.

When a net change is needed, a diver is required to disconnect the net bag bottom corners from the slender tube. In addition, a service boat with a powerful crane and four men are needed to manage the procedure for some five hours. The weight attached to the feed into
and the superstructure is very helpful when the fouled net bag is to be pulled and lifted out of the water on board the boat.

To facilitate the cleaning of the large net bags, special net washing machines are used.

Offshore fish farms are always influenced by waves, wind, current and marine growth. Therefore, system inspections and maintenance must be carried out on a regular basis. Depending on the type of cage or system, the maintenance routines can vary; however, they must be carried out and followed. The FARMOCEAN system is divided into a steel structure, net bag, etc., automatic feeder and mooring system. There is a special maintenance routine for each of these.

Faster growth, lower mortality, and a reduced viral and bacterial illness have been some of the findings among fish in offshore fish farms compared with fish in conventional cages. The environmental problems that often occur inshore due to pollutants from fish farms will be greatly reduced when moving the cages and systems offshore as a result of e.g., deeper net bags, better water quality and exchange, and following the fish disease.

FARMOCEAN SYSTEMS are found in the Baltic, along the Atlantic coast of Europe, off the coast of Scotland, and in the Mediterranean Sea. While the first units were used for growing salmon and trout, the deliveries to the Mediterranean have been for seaweeds and seaweed (Slides 19, 20 & 21). This means that FARMOCEAN has experience in colder waters in Northern Europe as well as warmer conditions in the Mediterranean.

Offshore fish farming, as shown on the final slide, has been around for some ten years in Europe and other parts of the world. We believe it time now has come to North America as well. The very same reasons that worked elsewhere.

E.g.
- lack of suitable sites
- environmental aspects, and
- need for better water quality.
also apply on this side of the Atlantic. Moreover, the
disappearance of the wild fishing should open up op-
portunities in aquaculture.

We have used the first year for us in North
America to prove FARMOCERN and its offshore
systems. Articles in trade media have generated interest
in the product. While a first North American unit most
likely will be predicted overseas, our plan is to find
one or more subconcessions for manufacturing the
product in North America. Suitable candidates could
be small to medium-sized shipyards.

To sum up, it is safe to say that fish farming has
become an industry. As a result, it has also become
more complex. Today, not only the fish farmer, but
banks, authorities, and insurance companies play im-
portant roles.

Furthermore, it is not unlikely that consumer
groups will have more influence in the future. We
have, for instance, seen how the forest industry has
had to respond to consumer groups regarding their
harvesting practices. Similar demands on our industry can
also be expected. Offshore aquaculture can represent
an opportunity in this area.

Therefore, it is essential that the suppliers of cages
and systems can provide the buyers, the fish farming
companies, and the ultimate consumers with relevant
and valuable information on their equipment, so they
can base their decisions on correct evaluations.

Thank you for your attention.

A Comparison of the Financial
Feasibility of Three Offshore Cage Systems
for the Production of Sea Bream in the
Mediterranean

Ljudmila Bugrove
SAMCO-SHIFIT Ltd.,
St. Petersburg, Russia

INTRODUCTION

Today cage manufacturer can offer different sys-
tems that significantly vary as far design criteria, op-
eration parameters and cost. Choice of a particular sys-
tem considerably depends upon hydrometeorological
conditions of the given area.

With distancing offshore, storm danger increases,
which stipulates special requirements to creation of
cage forms at exposed areas.

There are different types of systems specially de-
signed for application at exposed water areas. Gener-
ally, these systems can be divided into three main
groups: floating, semi-submerged and submerged sys-
tems. It is very difficult to compare them, for technical
differences within one group are often greater than be-
tween systems of different groups. However, for open
sea conditions the fundamental choice of a system is
directly connected to ultimate limits characteristic for
each of the three groups.

Thus, floating systems can be deployed at places
with maximum wave height below five meters and
with exposure level of 0.15. From engineering point of
view, calculation of a system on wave impact can provide a 100
percent guarantee of the structure strength under
storms. This is due both due to the complexity of wave
process and to the imperfection of calculation of storm
impacts that occur once every hundred years that
would lead to considerable rise in cost of the struc-

134