the production line
functions and equipment

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An essential part for a good hatchery is constant flow of fresh seawater.

The optimal water temperature for seaweed is 10 °C.

For a stable and cold temperature, salt water is pumped into the facility from about 60 m below sea level.

The salt water runs through a membrane filter to remove particles and UV treated to avoid contamination before it leads through pipes to growing rooms and a room with fertile seaweed.

For the temperature to be stable it’s good to locate these rooms close to the machine.

Salt water treatment machine
To grow seaweed you need spores from fertile seaweed.

Storage for fertile seaweed need a separate room to avoid contamination between different processes (growing room).

The room need space to store bulk containers with fertile seaweed, controlled light and temperature conditions, and constant supply with treated salt water.
For this process the worker needs a workbench with vacuum ventilation

On the fertile seaweed its dark reproduction patches called sori, this is where the spores are located.

The fertile seaweed gets sterilized before small parts from the sori is taken out, dried, washed and left in a cold storage (10°C) over night.

In this process, together with the correct light conditions to simulate winter season, the seaweed will release the spores when you add water again.

With a microscope the researcher count the spores and calculate the concentration before they are sprayed onto spools.
**Spools**

To make the spools, a spinning machine apply thin culture string (1.2mm) onto drain pipes.

The finished spools are left in freshwater for a few hours to realise oil from the tread.

They are washed in a washing machine at 70° before they are dried and ready for the spores to be applied.
Spraying cultures onto spools

Attaching spores onto spools requires a closed room.

The researcher distributes the spores evenly by spraying them onto the spools.
Growing rooms need controlled light and temperature conditions, and constant salt water supply for the spores to grow into sporophytes.

The room need space for growing cylinders and a small workstation to examine the growth.

We have 3 growing rooms in our facility.
**Plexiglass cultivation cylinders**

The spools with seeded strings are arranged inside the cylinders.

Cylinders are arranged along the walls inside the growing rooms.

Each cylinder is 150 cm high and 60 cm diameter.

The cylinder is translucent with light installations inside and outside for optimal growth conditions.

Salt water supply to each cylinder gives an even flow of fresh cold salt water.

Each cylinder has the capacity of about 5500 m cultured strings.

We have 4 cylinders in each growing room.
Cultivation time

The cultures strings stay inside the growing rooms for 30-35 days for the spores to grow into 1-2 mm long sporophytes.

Now they are ready to be transported out to the growing fields in the archipelago.
Transportation to growing field

The spools are removed from the cylinders and moved to transportation containers.

The spools get covered with wet paper towels to not dry out.

Now they are ready for transportation to the growing fields in the archipelago.
The culture string is 1.2 mm diameter, and this is what the sporophytes are growing on.

When the sporophytes are ready for deployment of shore, the culture string is brought to the growing field and twisted around larger ropes in the water.
Fixed to the seafloor by anchors or bolts, growing fields of floating frames are located at various locations in the archipelago.

The field consists of thick framing ropes located 1-2 m underneath the water surface, floating by larger corner buoys.

The buoys are the only visible part of the growing fields above water.

Each growing field covers 150 x 400 m with small buoys each 50 m keeps the ropes on a stable height when the seaweed starts to grow.

The growing field is divided into 16 units of 50 x 75 m, making it possible to harvest the seaweed systematically from the outside of the growing field.
Two different vessels are needed

A small vessel for transporting/attaching cultured strings in the growing field and observation

A catamaran for harvesting the seaweed. The vessel has a system for collecting/pulling the rope, a crane and space to stack harvesting bulk containers

The catamaran is 15 x 8 m, and can fit 32 containers (1000 l)
Harvesting

A harvesting rig (A frame) is installed at the back of the boat.

The rope with seaweed is pulled up by a winch and through a hock.

The seaweed is removed from the rope by the hock before it falls into a harvesting bulk container.

The rope is collected and cleaned/dried on shore.

When drying hanging seaweed in a drying hall its collected and transported when still attached to the rope.
Harvesting bulk containers

Bulk containers are used for transporting the seaweed from the growing field to the processing facility.

The capacity of each bulk container is 1000 l, and this volume can fit around 250 kg seaweed.

The seaweed is transported without adding salt water to the containers.

A lid is put on to protect the seaweed from sunlight and not dry out. It can stay in the container for 2–6 hours before it needs to be processed or moved to a cold storage.
Harvesting cycles

The seaweed is harvested within 3-4 months (March-June).

It’s intense and requires a lot of manual labor.

It’s preferred to wait as long as possible to increase the volume of the seaweed, but fast enough to not ruin the quality of the seaweed when the temperature of the water rises.
The dock

At the dock, the harvesting bulk containers are lifted by a crane onto rails on shore.

One side of the dock is organized to optimize the transportation from the sea to the processing facility on rails.

This space is for the machines, the workers, the industry.

The other side is dedicated to the community, for recreation and observation.

A spatial dock with good overview is important for safety.
For safer and less labor demanding work, the heavy bulk containers with fresh seaweed is transported from the dock into the processing space on rails.
The bulk tilter tilts the seaweed into a larger container with fresh seawater to clean it.

Cleaned seaweed is transported with a short conveyor belt to spread it out and remove excess water before further processing.
From the bulk tilter, the seaweed is transported to a conveyor belt, through a metal detector, before its manually inspected by 3-4 people on each side.

This belt is also used for fish processing.
Chopping machine - medium

The machine is chopping the seaweed before its vacuum packed or smoked
**Vacuum packing**

A work bench with scale and vacuum packing machines

Fresh seaweed gets vacuum packed (120 g portions) and then frozen

The same equipment will be used for fish processing
Industrial smoker

A closed room to smoke seaweed and other resources
Grinding machine

The seaweed is grinded before fermentation or to be dried in a drying room with convey belt.
Fermentation

A 1000 l closed bulk containers for fermenting the seaweed

Fermented seaweed is not for food consumption

Seaweed not good enough for food processing is fermented and used as organic fertiliser for the local farmers
In a closed room, grinded seaweed is dried on a convoy belt with slow speed

Seaweed is supplied from the top, and transported through the room into a container for dry seaweed at the bottom

The drying process takes a few hours

After being dried, it is stored in a dry storage until it is packed

This is mainly used to make seaweed spices
Drying hall- hanging seaweed

To satisfy today requirements for food processing industry in Norway, the seaweed need to be dried in a controlled climatized environment.

Ropes the seaweed was growing on is directly hanged onto hooks every 3 meters.

It’s important to avoid too long of a span so that the rope will stay straight between the hooks and the seaweed gets even airflow from all directions.

Seaweed for food consumption should be dried at 35 degrees Celsius as this temperature is optimal to preserve the best flavor and quality.

By supplying dry heated air into the drying hall from several installations in the floor, the seaweed will dry evenly.

The seaweed will reduce its water content with 90%, and to optimise the space for drying hanging seaweed, a draining system in the floor is necessary.

By hanging two levels of seaweed in a 180 sqm space, you can dry 3.5 tons within 48-72 hours.

The maximum growing length of the seaweed sugar kelp is 2.5m.

We need 2.5 m height for one level of seaweed, and additional 0.5 m buffer zone from the ground and up to the seaweed.

When hanging the seaweed in two levels, we need a minimum height of 5.5 m in the drying hall.
Collective production

maximum 3 meter inbetween

2.5 maximum growing length

clean buffer zone
Storage

In the facility we need frozen, cold and dry storages

To optimise the use of the storages, depending on what kind of resources being processed, all storages has the possibility to be, frozen, cold or dry storage

and the storages are located along a loading/unloading area for further distribution by truck

equipment
**Transport**

*Pallet truck*
inside the facility

*Truck*
A truck with maximum length of 8m so that the truck can turn on the property of small farms and suppliers of local resources
the production line

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