Circular economy in an agricultural vocational training center

ASTURIAS. SPAIN.

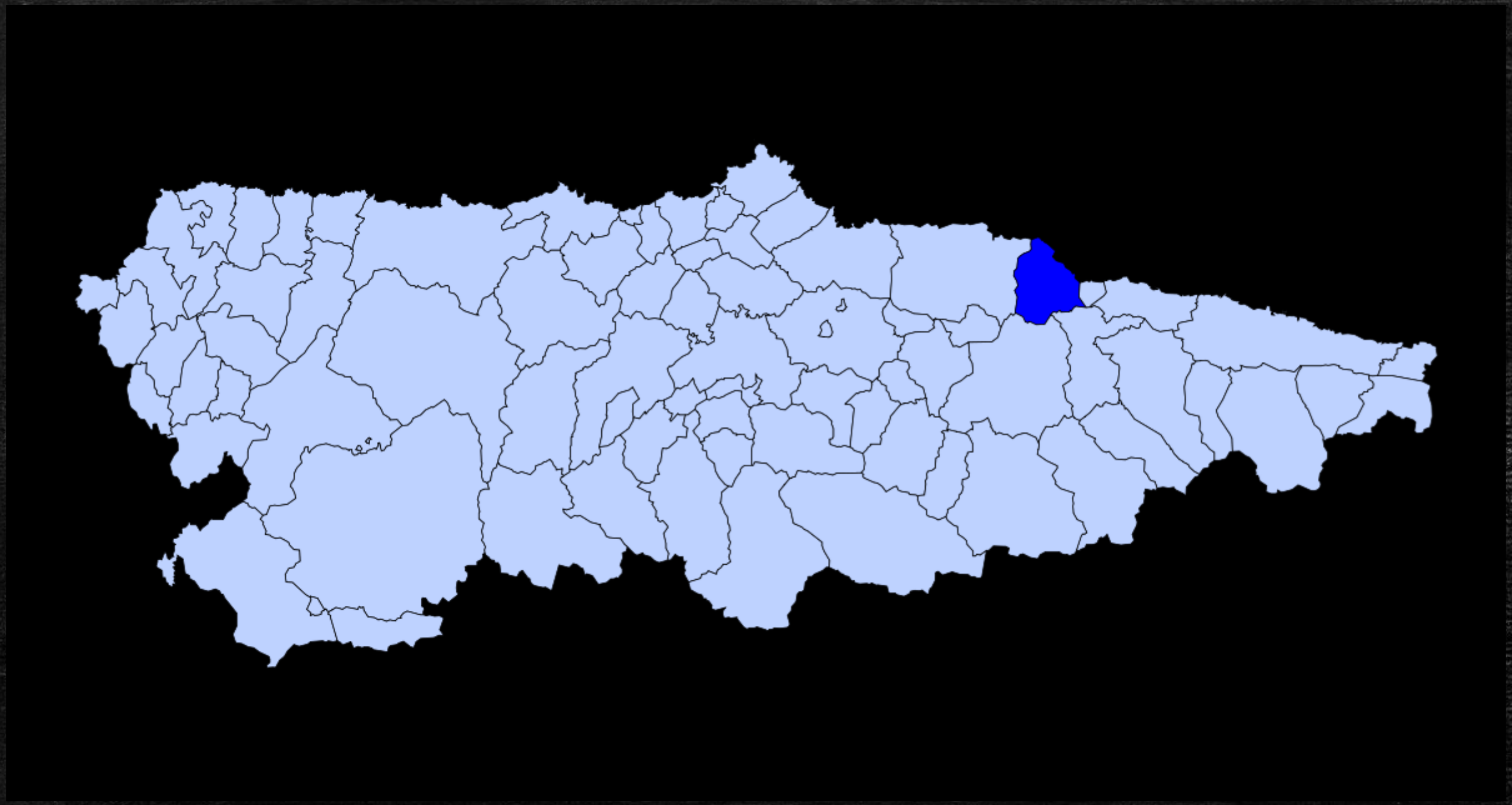
Índice

1. Location
2. School Project
3. Agriculture innovation project

1. Location

Luces. Colunga. Asturias

- The area of Colunga its localted at the Center-east of the Asturias coast. Colunga is a very popular place for tourism due to the bereathtaking landscapes, wild cliffs, smooth rolling mountains, beatiful beaches and picturesque towns as Lastres.
- The central east coast of Asturias is an important place of fossils and footprints of large dinosaurs that inhabited this land for millions of years.
- The Jurassic Museum of Asturias is a unique building designed as a shape of a large dinosaur footprint and is home to one of the most comprehensive and concise collection of these factinating reptiles.



Lastres

IES Luces

- It's a working farm with 50 hectáreas divided among 25 fields in the town of Lastres.
- Our farm produces sustainable milk, vegetables, honey, flowers and trees.

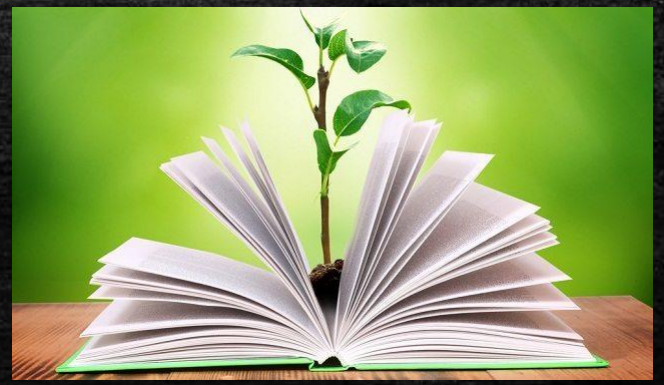
2. School Project

Studies

- Compulsory secondary education
- Upper secondary education
  - Bachillerato
- Vocational training
  - Intermediate vocational training
    - Technician in Agro-ecological Production
    - Technician in Gardening and Floristry
  - Higher vocational training
    - Higher Technician in Forest and Natural Environment Management
    - Higher Technician in Livestock and Animal Healthcare

Our philosophy

- **Education for sustainability** develops the knowledge, skills, values and world-views necessary for people to act in ways that contribute to more sustainable patterns of living. … It enables individuals and communities to reflect on ways of interpreting and engaging with the world.
- **TECHNOLOGICAL AND DIDACTIC INNOVATION** in the teaching of Vocational Training



3. Agriculture innovation projects

Cooperation project

- IES luces and the start up NEOALGAE, cooperate in a collaborative project of applied innovation and knowledge transfer in Vocational Training, financed by the Ministry of Education and Vocational Training and co-financed by the European Social Fund within the framework "Operational Program for Employment, Training and Education ESF 2014-2020" .

neo ALGAE
micro seaweed products

Goals

- Circular economy
- Development new skills (students and teachers)
- Incorporation of new technologies
- **Encourage of creativity, talent and entrepreneurship**
- Set up relationships between the school and companies

The project

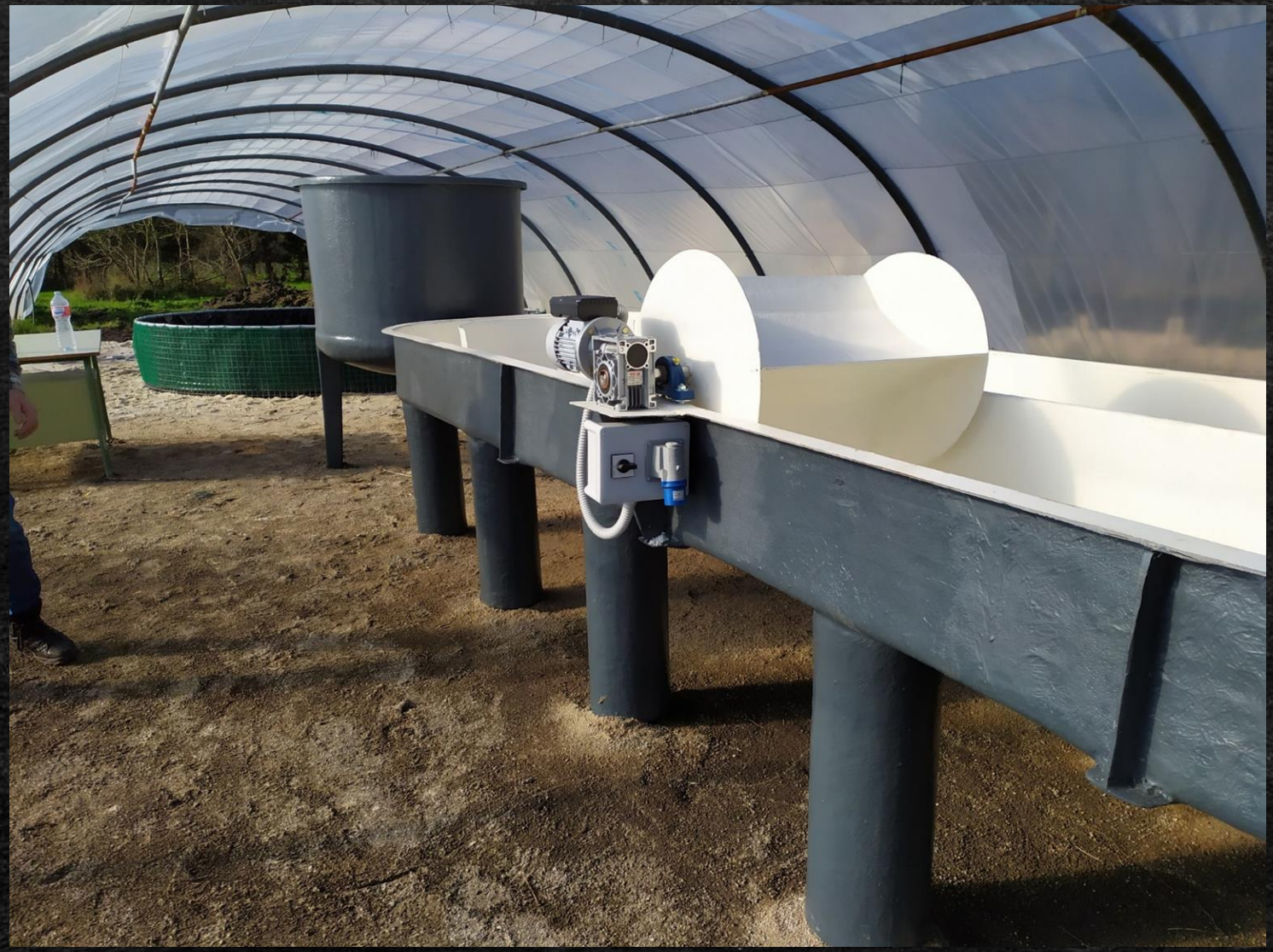
- The project consists of cultivating the spirulina alga (Arthrospira platensis) in photo-bioreactors built for this purpose at the Center and using the slurry from the dairy cattle as a culture medium.
- As final products:
  - algae which once dried can be used as fertilizer or food for the farm's cattle
  - purified water suitable for irrigation

Facility

- Containers
- Pool (Raceway)
- A greenhouse

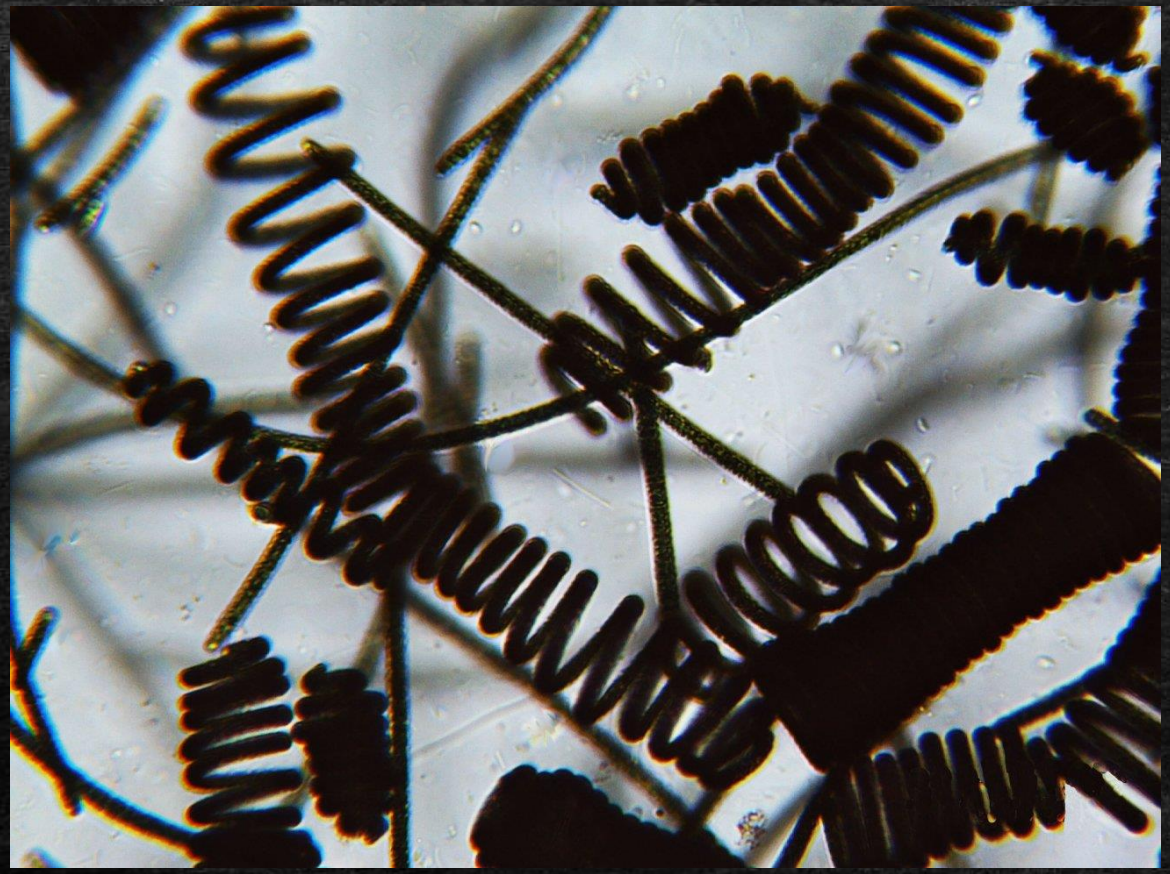
Container

Raceway



Fundamentals of growing spirulina

- Actually, and unlike the popular belief, it is not an alga, but a cyanobacterium, although some official bodies still call it "alga".
- The Latin word *Spirulina* means "*small spiral*" and describes a structure that has this shape.
- Spirulina has a multicellular structure and develops as a plankton in freshwater. Today, it is known that there are more than thirty species of Spirulina.
- *Spirulina platensis* appeared on Earth 3.5 billion years ago and thus became the first organisms capable of photosynthesis.
- This role was fundamental for our planet, since it reduced the so high levels of carbon dioxide, thus promoting an oxygen-rich atmosphere.



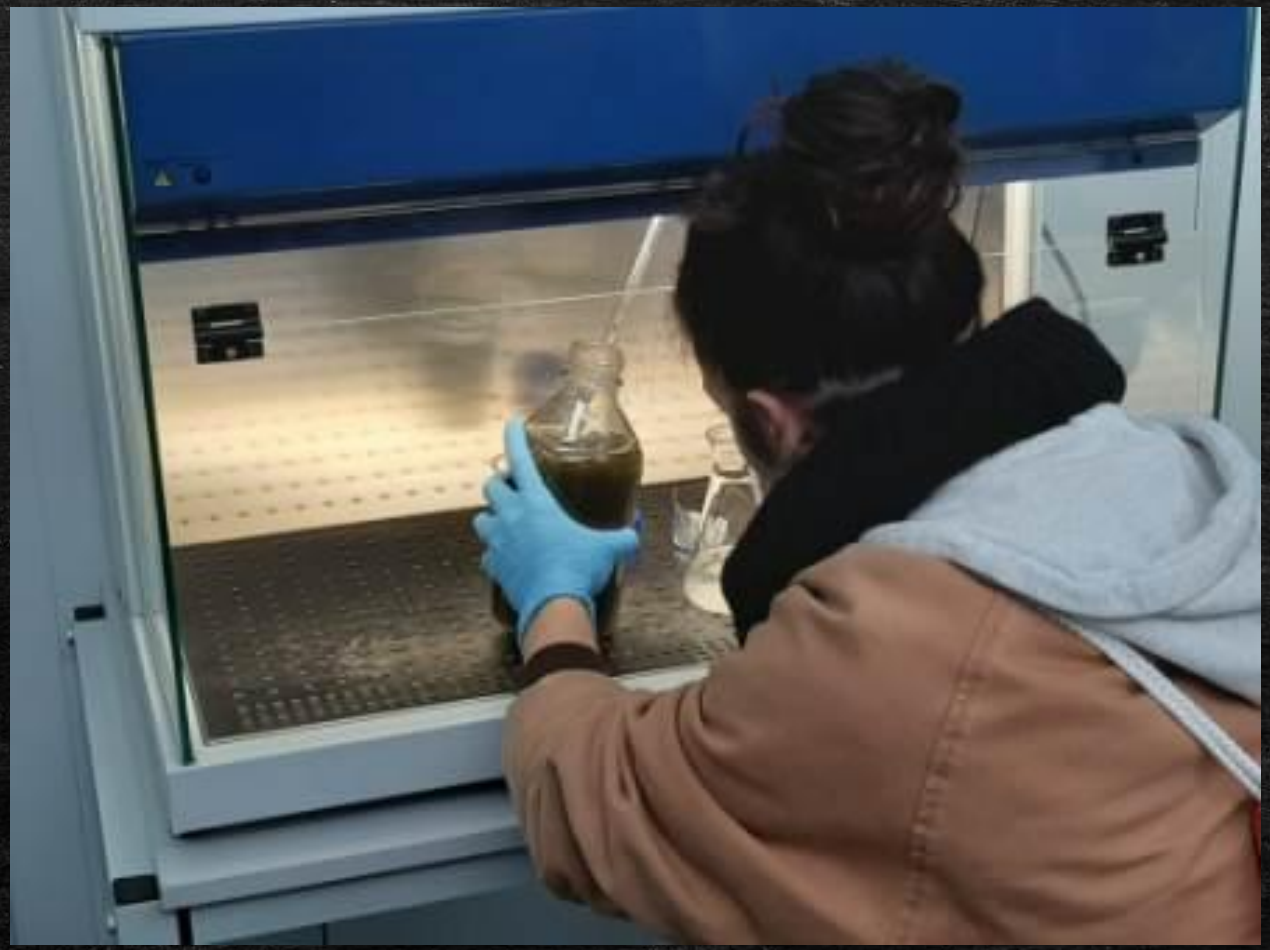
Spirulina platensis

Spirulina cultivation

- First of all, you have to get the spirulina primary culture (is the living cyanobacteria needed to start the spirulina production). We acquired our first batch of spirulina from NEOALGAE.
- Spirulina needs sunlight, water, fertilizers and agitation
- We mix spirulina primary culture, fertilizers and water in a tank.
- We should make sure that the container with spirulina gets enough sunshine.
- With proper sunshine, Spirulina will take a minimum of 10 to 15 days to develop.

Spirulina primary culture

NEOALGAE
ceparium



Student preparing spirulina culture in NEOALGAE's ceparium

Spirulina growing culture

- All Spirulina culture mediums are based on the Zarouk Medium and consist of the following elements: Nitrogen, phosphorus and potassium in large quantities; Sulfur, magnesium and calcium in smaller quantities
- **WEIGH AND MIX FERTILIZERS WITH WATER**
  - The following measurements are for 100 liters water:
    - 1000g Sodium Bicarbonate ($NaHCO_3$)
    - 500g Sodium Chloride (NaCl)
    - 10 g Iron Sulfate ($FeSO_4$)
    - 25 liters slurry from the cattle farm
    - 100 liters spirulina

Spirulina cultivation start (Luces students)

Monitoring

- As in any agriculture crop, it is important to keep track of the status of the Spirulina and of the environment. This close monitoring will enable quality control, early detection of problems and continuous improvement in farming methods.
- The crucial elements that need to be monitored are: temperature (of culture and of air), pH level, culture depth, radiation (amount of light), density.
  - **Temperature** - Optimal temperature for Spirulina is 30-35°C. Spirulina can survive lower (not below 20°C) and slightly higher temperatures (up to 38°C), but it is not advisable as its metabolism will be harmed and it may suffer from a state of 'shock'. Temperatures can be measured with a thermometer.
  - **pH level** – Spirulina can live in a pH level that ranges 8 to 11, but it is at its best at 10.5-11., which is the level that needs to be maintained, as below 10.5 it is at risk of being contaminated and over 11 it undergoes chemical changes.

pH level

Monitoring

- **Density** - Amount of light that passed through the culture gives a good indication to the density of it, indicating if it is ready for harvest (or for increasing its amount) or if density is dangerously low.
- There are several ways to estimate density:
  - Color of the culture - the darker the green the denser the culture.
  - A second option is looking at a sample from the culture in the microscope - the number of Spirulina filaments and their proximity to one another is a good indication to the culture density.
  - A third option - an X is written on a white sheet of paper. A transparent graduated cylinder is placed over the X. Spirulina culture is poured into the cylinder until the X is no longer visible from the top of the cylinder. The higher the level at which the X is seen the lower the density.

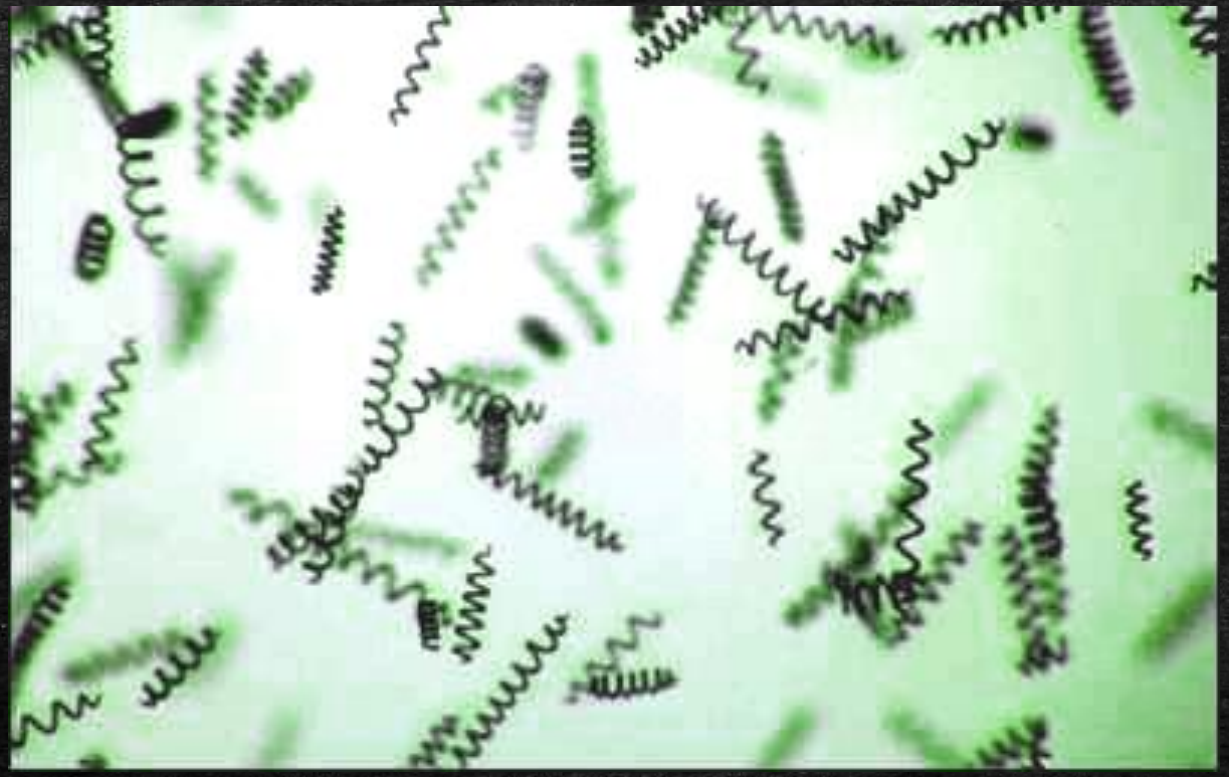
Funcionamiento del espirulímetro

El espirulímetro es lo que se conoce en los laboratorios como *disco de Secchi*. Éste consiste en un escala graduada y al inicio de ésta un fondo blanco. Funciona submergiéndolo en el agua y anotando los cm que ha descendido hasta que se deja de ver el fondo blanco. Los cm que ha descendido indican la turbidez del agua, y en éste caso también indica la concentración de espirulina.

Density

Culture sampling

Daily care of spirulina



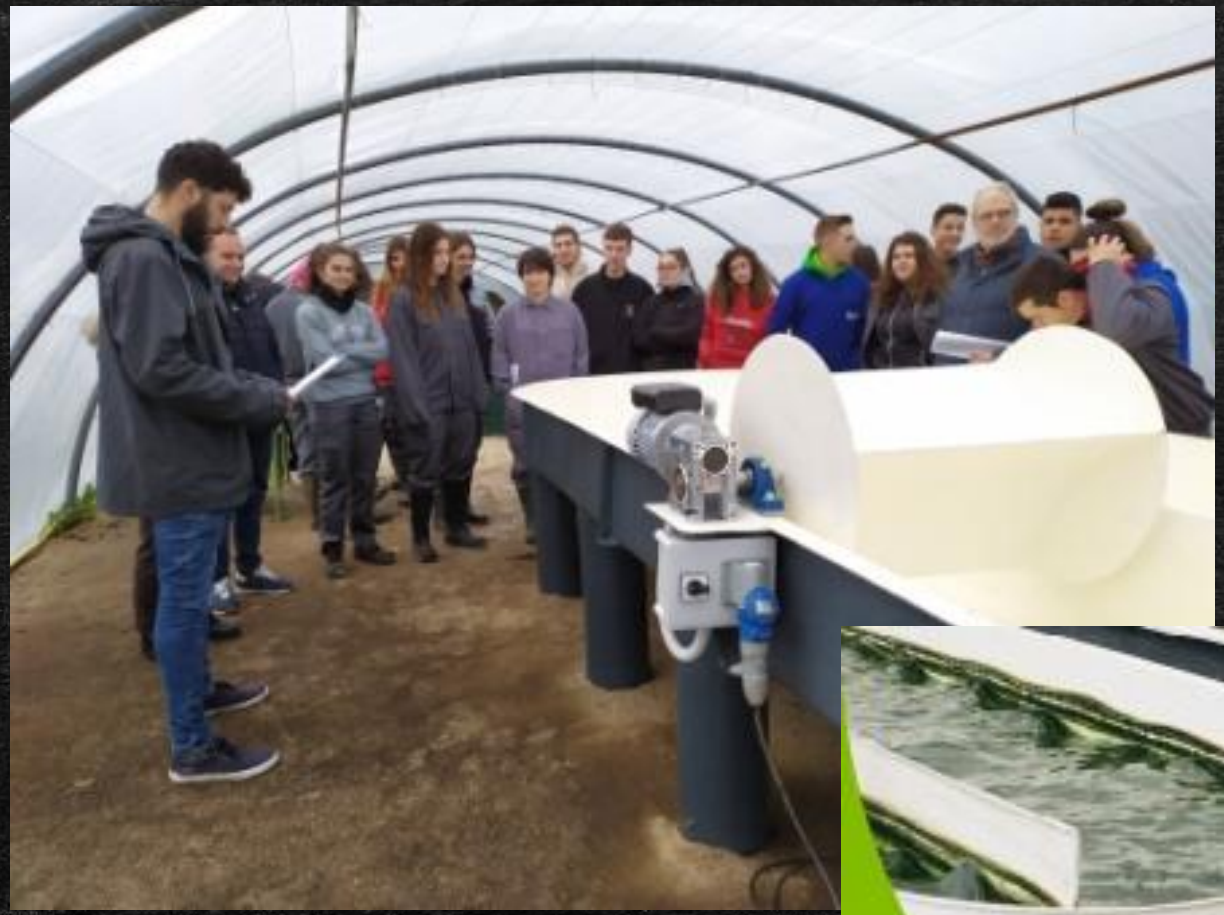
Microalgae seen under the microscope. View enlarged x 100. A filament (a spirulina) measures approximately 0.1mm.

Spirulina farming cycles

- Spirulina's reproduction is asexual. Given the right conditions (temperature, lights, fertilizers, agitation) it doubles itself approximately every 48 hours.
- When Spirulina is mature and dense (this can be estimated by the dark green color of the culture, with a microscope or with a graduated cylinder, as it was peviously described) it is ready for one of the following procedures:
  - **Increasing amount of Spirulina**
  - **Harvesting Spirulina**

Increasing the amount of spirulina

- To increase the amount of Spirulina, mature and dense Spirulina is diluted with culture medium (water and fertilizers) in a ratio that is roughly 1:1., thus multiplying the quantity. For example: 100 liters culture medium are added to 100 liters of mature and dense Spirulina. The new quantity of 200 liters will be diluted and thin, but given the proper care and approximately 48 hours it will once again be mature and dense and then ready for yet another multiplication.
- When increasing the quantity of Spirulina, the measurement of the pool or container must be adapted. We finished the process in the pool (raceway).



Raceway

Harvesting

- Harvesting spirulina is a delicate process that requires attention, precision and above all, hygiene.
- There are many ways to harvest and dry the fresh spirulina biomass:
  - Using a nylon filter of 30 microns to separate the biomass of spirulina from the liquid culture.
  - Using a strainer or similar to separate spirulina
- The Spirulina will at this point still have some residue of the culture medium. In order to bring the Spirulina to a pH level that is healthy for consumption (7pH), these residues need to be eliminated. To do so press the filtering cloth (with the Spirulina in it) evenly and gently. The culture medium - which is transparent – will drain from the cloth. When the water draining through the filtering cloth is no longer transparent but green, stop squeezing - this means that all the culture medium has been squeezed out and the Spirulina is at a healthy pH level.

Harvesting using a strainer

Harvesting using nylon filter

Spirulina after filtering

Drying spirulina

- Drying Spirulina is a more efficient and long lasting option. In its dried form it can be kept for many months, as long as it is stored in clean and damp free containers.
- Spirulina that is not consumed immediately after harvest can be frozen (in plastic bags or containers) and kept for 2-3 weeks.
- Spread Spirulina on a clean surface and let the sun dry it.

Use of Spirulina

- Can be used for the production of valuable commodities such as animal feeds and agricultural fertilizers, among others.
  - The potential benefits of recycling this algal biomass back to arable soil , on plant growth and nutrition and physical and chemical properties of the soil.
  - Spirulina algae supplementation increases microbial protein production and feed intake and decreases retention time of digesta in the rumen of cattle
- But also, the slurries from the cattle farms that is an environment problem, became a solution. This effluent is used as a nutrient source during cultivation of the microalgae Spirulina, in addition the water used in the microalgae cultivation is recycling and suitable for irrigation.
- In conclusion “circular-economy”.

Students involved in the algae project

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