**Constructing Your Spirulina Farm**

1. **Decide how much Spirulina you need (and where to put it)**

Under ideal conditions, your farm will grow by 80mg (wet weight) per litre per day. Using the nutrient recipes and heater provided, the limiting factor will be the amount of light your farm receives (so having a spot which gets sunlight all day is important).

A 20L farm can produce about 10 - 15g in a week (or 2 to 3 teaspoons of concentrated, wet green goodness every few days)

1. **Choose your container**

Your container must be

* Watertight
* Transparent or translucent
* Lidded

Plastic storage containers are a readily available, cheap option, with the advantage of coming in a wide range of sizes to match your requirements.

1. **Make an air-lift pump to aid circulation and gas exchange**

This simple device helps your farm stay productive by

* circulating the growing spirulina (which ensures all the individual cells get their time in the sun) and
* aerating the liquid, which helps remove excess oxygen being produced and adds carbon dioxide necessary for growth

Cut a length of plastic pipe about 15mm diameter that will fit along the side of your container. Rigid tubing (like plumbing pipe) is easier to fix in place than soft PVC, but either will work.

Drill a hole about 1cm from one end that will make a tight fit for your air tubing, and insert a length of air tube so that about 3-4cm is inside the pipe. The length of the air tube required will depend on where you locate the fish tank pump when you install the farm.

Fit suction caps at both ends of the air-lift pipe, and fix one end inside the farm container a few centimetres from the bottom. The other end is placed a few centimetres above the level of the liquid.

1. **Install the heater and temperature sensor**

The optimum growing temperature for spirulina is 25 – 37oC , and installing a heater will ensure maximum production. Above 40oC, the organism begins to die and break down, which is why the temperature sensor is useful.

Both are easy to install in your farm:

* Set the temperature control to somewhere in the optimum range - if your farm will be in a very sunny spot, choosing the lower end of the range might be advisable.
* Attach the heating element to the bottom of the farm using suction grippers (underneath the air-lift pump is a good place).
* The temperature sensor is battery operated, and all you need to do is dangle it in the liquid.
1. **Connect the fish tank pump air lines**
* Cut a short length of 5mm tubing, and attach it to the air outlet.
* Attach the one-way valve (which prevents back flow damaging the pump), You can check you have it the right way round by turning on the pump, and ensuring you can feel air coming through the valve.
* Cut another short length of tubing and attach it to the valve outlet.
* Connect the tubing to the bottom of the T-shaped control valve
* One of the T-arms connects to the tubing running to the air-lift pump
* Connect a length of tubing with a bubble stone on the end to the other T-arm.

It is worth filling the farm with water and testing that everything works before adding the spirulina.

* Set the upper end of the air-lift pump a few centimetres above the surface of the liquid
* The air-lift pump should produce a gentle burbling of liquid (too vigorous, and the cells could be damaged). Adjust this by using the control knob on the top of the T-valve from the fish tank pump.
* Turn the heater on, and leave the system running for a couple of hours. Check the temperature is in the optimum zone, and adjust if necessary.

**Feeding and fertilizing**

**Nutrients**

Photosynthetic organisms like spirulina make most of the materials for their growth from air, water and sunlight, but just like plants they require other nutrients for survival. Almost all of the necessary ingredients for a growth medium can be found in the fertilizer section of your local hardware store.

1. **Water**

Tapwater contains chemicals which are added to stop organisms like algae growing in it, and these need to be neutralised if this is your water source. This is easy – just add 1 teaspoon of Vitamin C (ascorbic acid) powder per 5L of tapwater, and shake. Other methods can be used too (aquarium owners have the same problem, and water purification tablets can be purchased from pet supplies shops). Some filters can also remove these chemicals, but you need to check their specifications.

Leaving the water in the sun for a while will not work since modern water treatments do not use volatile chlorine gas any more.

Rainwater is another option, but the risk of contamination with other organisms is higher.

1. **Growing medium**

The quantities below make up 5L of growing solution:

|  |  |
| --- | --- |
| **Nutrient** | **Mass in 5L** |
| Sodium bicarbonate (baking soda) | 80g |
| Potassium (or sodium) nitrate\* | 10g |
| Unrefined sea or rock salt (NOT iodised) | 5g |
| Ammonium phosphate\* | 0.5g |
| Iron sulphate \*\* | 0.05g |
| Magnesium sulphate (Epsom salts) | 0.5g |
| Potassium sulphate (Potash) | 2.5g |
| Calcium chloride (spa water hardener) | 0.5g |

If you do not have a suitable set of scales, 1 level teaspoon is about 4g of any dry powder.

\*These will not be in the hardware, but are readily available from a chemical or laboratory supplies company (eg: Auschem or Labtek in Brisbane). They have the advantage of being very soluble.

Substitution is possible, but growth might be decreased

Ammonium sulphate fertilizer can replace the potassium nitrate, but at 1.5g / 5L

Superphosphate can replace the ammonium phosphate, at 0.5g/L but needs to be crushed to improve solubility.

\*\*Iron remains more soluble if it is dissolved in strong green tea. Make up a solution of iron sulphate at 1g/100mL in cold tea, and add 5mL (one teaspoon) of this mix per 5L of growth medium.

1. **Replacement nutrients**

After harvesting your spirulina, you will need to add nutrients to replace those used during growth. Make up the following as a dry powder.

|  |  |
| --- | --- |
| **Nutrient** | **mass** |
| Potassium nitrate | 100g |
| Ammonium phosphate | 5g |
| Magnesium sulphate | 5g |
| Potassium sulphate | 25g |

* Mix very thoroughly
* Estimate the volume of wet, harvested spirulina
* Add 1/3 of this volume of the dry, mixed replacement nutrients to the depleted growth medium
* Add a further 5mL of your iron sulphate /green tea solution, too.
1. **Using artificial lighting**

Sunlight is recommended because it is 10-100 times more intense than artificial sources. LED grow lights are an alternative if you do not have a suitable sunny spot. Red light is all that is needed for photosynthesis, but warm white could serve as well.

Expect slower growth under these conditions, and ensure a 16/8hr light/dark cycle for healthy cultures.

**Starting your culture**

Spirulina grows best when it is not too dilute, and keeping the growing culture at a high density also reduces the risk of contamination with other organisms. It is best to gradually increase the volume of your culture, rather than adding the starter to a large volume of nutrient medium.

* Make up 5L of growth medium by following the directions above
* Put the starter culture into a larger, clear plastic container (rinsed water bottles work, as do small cleaned clear plastic storage containers)
* Place the container in a warm, sunny spot.
* Supply some shade initially, by wrapping thin gauzy cloth or translucent greaseproof paper around the outside of the container (this can be removed when it is more established)
* Cut some air tubing, attach to the fish tank pump , and start it bubbling gently in the culture (no need for an air stone at this stage)
* Add a volume of the growth solution about 1/3 the volume of the spirulina culture
* Repeat every 2-4 days, waiting longer if growth is slow, so the culture stays dark green rather than getting thin and watery
* Move the growing culture to a larger container when necessary, but keep the bubbler going to help maintain gentle circulation and gas exchange
* Once you get to 5L, transfer to you farm container, and continue slowly increasing the volume until you reach your desired amount

**Danger signs**

If the spirulina has brown, white or yellow bits floating around, scoop them put and do not eat them

If you are concerned, check the pH of your culture: do not harvest if the pH is below 10, but add more nutrients and wait for further growth.

If the culture of harvested material smells off, do not eat it. Healthy spirulina has a slightly fishy or seaweedy scent.

Keep some backup culture on the go in smaller containers, so that you can restart the farm if something goes wrong. Keep them in a shady spot and bubble air through slowly (don’t use a heater) so they grow slowly. You will need to monitor them, and dilute as necessary.

**Harvesting**

**Making a Secchi disk**

The easiest way to measure the density of growing spirulina is using a Secchi disk.

* Cut a roundish piece of white plastic from the lid of a plastic container about 50mm diameter.
* Draw several (4 -8) black lines across the disc with a permanent marker. Diameter lines make the next step easier/.
* Pierce a hole in the centre of the disk
* Push a skewer or chopstick through the centre hole so the disc sits a few cm from the point of the skewer
* Mark 1cm intervals on the skewer above the disk with the permanent marker

The device works by lowering it into the spirulina culture until you can no longer see the lines when looking down through the liquid. When the black lines become invisible if the disk is 3cm or less below the surface, the culture is ready to harvest.

At a reading of 2cm, the culture will yield 0.5g/L dry product, at 4cm the yield will be about 0.3g/L.

**Harvesting**

A healthy farm can be harvested every 3-4 days, using a simple filter method. Harvest mesh could be a 50 micron nylon filter, or porous fabric like Swiss voile (curtain backing). The mesh can be rinsed in dechlorinated water and reused.

* Peg the harvest mesh loosely across the top of a clean bucket or container. Ideally the container will be large enough to hold the total volume of culture medium.
* Siphon the culture liquid from your farm, through the mesh and into the bucket. You could use a clean length of plastic tubing, or a squeeze pump available cheaply from hardware stores. Failing this, a clean dipper will do the job, but more slowly.
* Gently agitate the mass of spirulina that will collect on the harvest mesh to keep it flowing.
* Scoop the spirulina towards the centre of the mesh with a spoon.
* Unclip the mesh, and squeeze out excess liquid
* Return the growth medium to the farm
* Estimate the volume of your harvest, and add replacement nutrients as required.

The product can be eaten fresh, refrigerated for 2-3 days, frozen or dried for storage.

**Further information and nutrient supplies**

SpirulinaGrowCo is an Australian supplier of pure cultures (if you need a replacement), and pre-mixed nutrients.

Their website has more information about care and maintenance of your farm, as well as nutritional data.

Obtaining cultures from overseas is not advised, because of biosecurity concerns, and the likelihood of the culture dying due to extended transit times.