AG2030- ALGACULTURE AND EFFICIENCY

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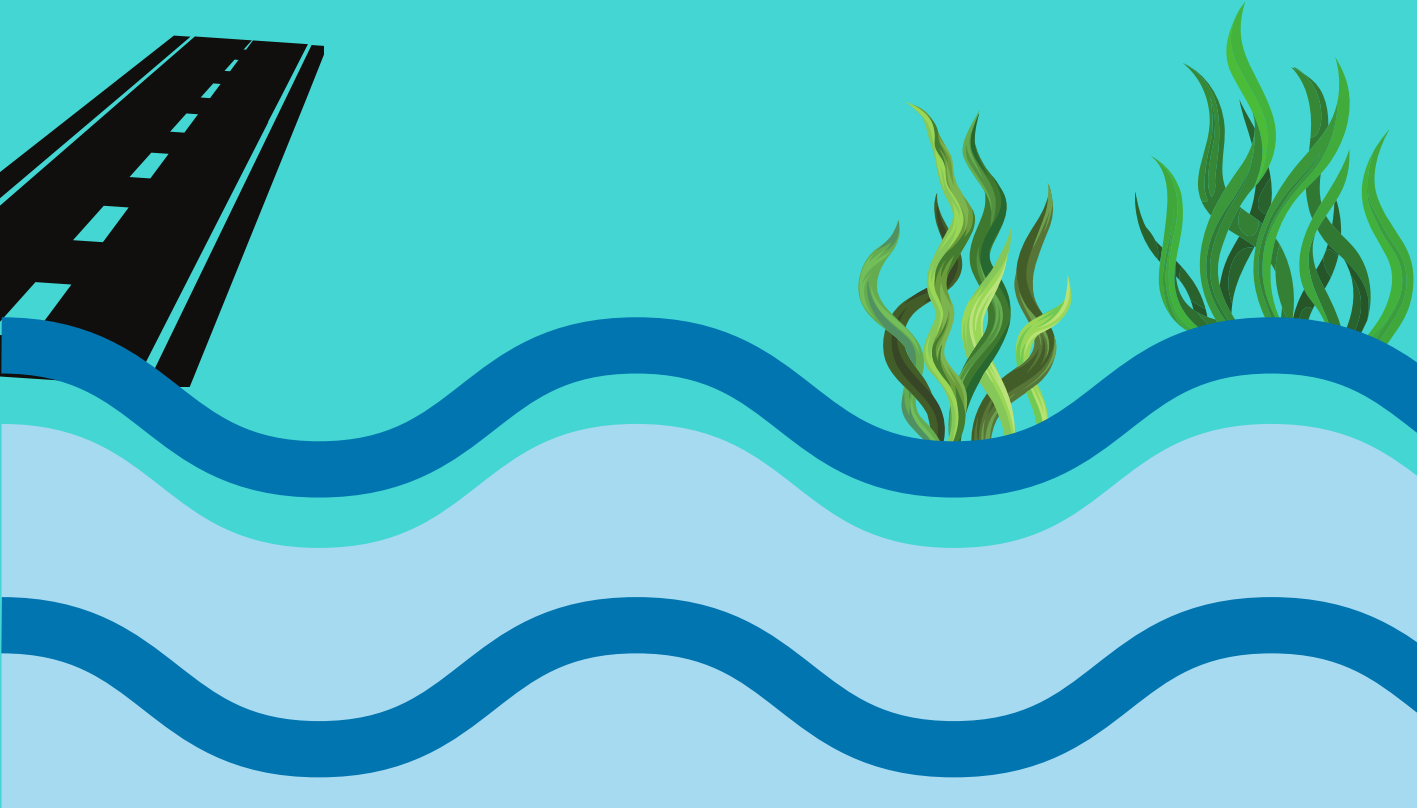


INTRODUCTION

Two centuries of trial and error supported by extensive research has placed the **Australian agricultural industry** firmly on the worlds stage. However, due to the vast number of **ineffective, inefficient, and outdated farming** practices still adopted by a majority of Australian farmers, there is **room for great improvement and expansion** far surpassing the Federal Government's goal of 100bn by 2030. To **Surpass 100bn by 2030** will require the widespread implementation of existing technology and the adoption of new practices.

Our proposal

We propose incentives to increase the number of **highly efficient overhead irrigation systems** and the adoption of widespread **microalgae farming**.

Microalgae is a versatile crop that, when **paired with advancing technologies,** has a large potential for a variety of uses as the agricultural climate changes, such as to **feed livestock, purify water, enrich human food, create biofuel, fertilisers and desalinate water**, all of which can contribute to sustainably boost the Australian economy. It is **easily and efficiently grown in water** instead of on our minimal amounts of arable land and has a variety of **nutrients** that will revitalise the diets of Australians who have been robbed of these nutrients due to decades of unsustainable land management.

MICROALGAE AND FOOD

Microalgae's nutrient superpowers

Microalgae such as chlorella and spirulina...

Provide **protein**, **magnesium**, zinc, copper, potassium, **calcium**, folic acid and other B vitamins, **omega-3 fatty acids**, vitamin A, riboflavin, iron and essential **amino acids**.

Chlorella and spirulina **supplements are available commercially**, however, there is potential for their nutritional value to be capitalised on by **integrating microalgae into common food**. Especially as we need to find more sustainable sources (such as microalgae) of important nutrients (above).

> ***MICROALGAE CLEARLY SHOW POTENTIAL TO MEET THE POPULATION'S NEEDS FOR MORE SUSTAINABLE FOOD SOLUTIONS***
>
> *Laboratory of Sustainable Food Processing,*

Microalgae and Protein

Livestock accounts for 56% of methane emissions in Australia and therefore there is a strong need to find **innovative protein alternatives** and transition away from livestock for protein.

The need is exacerbated as the percentage of **vegetarian** Australians **continue to rise** from 12.1% and with approximately one **billion people worldwide** having **inadequate protein** in their diets the need for protein-rich food has never been greater.

There are **existing alternate protein** sources, such as soybeans, however microalgae is a **more sustainable and efficient** alternative

Soybean

VS

Microalgae

35%-45% protein

30%-60% protein

Takes up valuable **land** to grow

Can grow in **water or use minimal land**

Produces **27 times more** protein per hectare than soybeans

Dried microalgae should be more highly considered as a protein alternative as it **grows so readily,** has **high protein** and **uses minimal land**.

Your future microalgae diet

Swiss start-up Alver have incorporated chlorella microalgae with 63% protein into **pasta** samples.

Euglena Co use chlorella microalgae as a protein substitute in **plant-based meats.**

Cookies are a viable medium through which microalgal benefits can be delivered.

Emergen Research reports that the alternative protein market is estimated to reach

$5.38 billion by 2027

demonstrating its economic potential .

There are still **limitations** in this area due to underdeveloped microalgae processing **technologies and research**- but potential is evident.

Shelf life and food waste

Photoautotrophic (as opposed to heterotrophic) microalgae enriched vegetable matter (specifically tomato, broccoli and carrot purees) have **high rates of oxidative stability.**

Oxidative stability: refers to the susceptibility of a food or edible oil to lipid oxidation, which causes rancid odors and flavors.

Microalgae enriched vegetable products are predicted to be oxidatively stable for at least

2 years

under refrigerated storage and 1 year at room temperature.

This could help **reduce food waste,** as microalgae enriched food would **taste and smell better** for longer and have a **longer shelf life**.

MICRO-ALGAE VERSATILITY

MICROALGAE IS ABLE TO SURVIVE IN BOTH

Salt & Fresh

WATER, GROWING WHERE OTHER CROPS CAN'T

Micro-algae is **extremely fast growing**, completing a growth cycle every few days.
Therefore, production is **efficient** with a ***high yield***

IT CAN BE GROWN

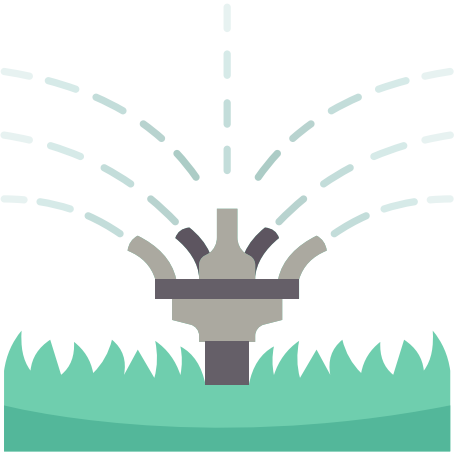
ALL YEAR ROUND

UNLIKE OTHER CROPS, WHICH ARE SEASONAL

in 2018, Qualitas farm, a micro-algae plant, produced **33 harvests**, while soybean farms only produced **1**.

no harmful **pesticides** and minimal **fertilisers** are needed, reducing:
- ***environmental*** *impact*
- ***cost*** of materials needed for its management.

In fact, Micro-algae itself can be used as a **fertiliser**



Micro-algae's ability to grow in all types of water salinities provides an **abundant**

SUPPLY OF WATER &

a **decrease** in

DEFORESTATION

(as desalinated water and arable land is not required) **lowering** both ***cost*** and ***environmental*** impact.

some species of micro-algae can absorb

UP TO

50 x

more salt than the concentration of salt in the water they inhabit

DESALINATION USING MICRO-ALGAE

Genetically modified micro-algae was shown to remove up to **30%** salinity in brackish water samples in just **one** treatment stage.

Microalgae is a cheaper, more renewable process that increases energy production and water availability for agriculture and decreases water expenses.

Microalgae is a more **SUSTAINABLE** and **COST-EFFECTIVE** tool for desalination, especially with the ever-looming threats of global warming and potable water shortages.

Micro-algae can be:

- re-used multiple times in the desalination process
- harvested as a biofuel material, reducing the use of fossil fuels. This could result in ~18 mil over 20 years

CO_2

Microalgae is among the most **PRODUCTIVE** biological systems for capturing carbon molecules

CARBON CAPTURING

THE CARBON-CAPTURING EFFICIENCIES OF MICRO-ALGAE ARE

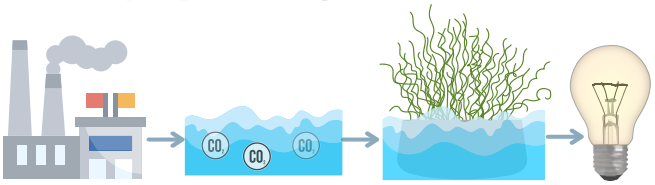
AS HIGH AS 90%

→ Situating micro-algae facilities around high CO2 producing sites (e.g power plants) both **reduces** these sites **CO2 emissions** and create a **cheaper CO2 source** for micro-algae fertilisation.

→ The scale of micro-algae needed to capture the vast amount of CO2 created by the facilities is manageable.

The captured CO2 is used as a 'fertiliser' which micro-algae converts into biomass through photosynthesis.

The micro-algae can then be harvested as a **food source** or for **alternative uses.**



The use of micro-algae for capturing CO2 (from high CO2 producing sites) is extremely environmentally friendly, efficient and cost-effective, due to the cheap, unlimited access to CO2 and therefore the large quantity of micro-algae which is produced.

Up to 90%
of CO2 can be captured from power plants, supporting up to 1000 acres of algae. This would offset 198 coal-fired power plants.

DROUGHT AND WATER WASTE MANAGEMENT

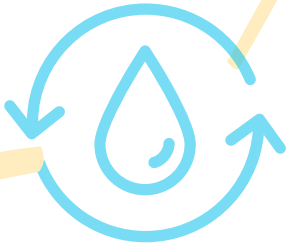
Micro-algae has the ability to remove nitrogen, phosphorus, heavy metals, pesticides, organic and inorganic toxins, and pathogens from wastewater.

Through photosynthesis, micro-algae provides oxygen to the anaerobic bacteria within the water, which then break down the organic contaminants, using up excess nitrogen and phosphorus in the process.

→ The decrease/elimination of water purifying chemicals added to the water lowers **PRODUCTION COST**, **POLLUTION** and the risk of health problems (e.g cancer, anemia, liver/liver problems, etc) commonly caused by such chemicals.

→ **COST** and **ENVIRONMENTAL IMPACT** can be further reduced by utilising the Microalgae's high levels of biomass, which can be used as an alternative energy source to power the sewerage plant.

→ The fast-growing nature of the algae and its ability to be reused also increases **EFFICIENCY**.



The treated water can then be repurposed as grey-water for crops, fields golf courses, etc (a method already successfully trialed in San Diego).

BENEFITS IN LIVESTOCK FEEDS

Microalgae genuses such as Chlorella and Spirulina have numerous benefits to livestock when **supplemented** with standard feeds.

The **proteins** and **essential fatty acids** found in these microalgae have significant benefit to animals general health, with improvements reported in **milk**, **egg** and **meat quality**. As well as **overall health improvements** of livestock including:

Only 30% of all processed microalgae is used as supplements in livestock feed to benefit animals

- Improved overall immune response
- Improved overall health & growth
- Improved gut function
- Improved resistance to disease
- Lowered cholesterol

BENEFITS IN POULTRY

Spirulina. An excellent source of protein for farm animals.

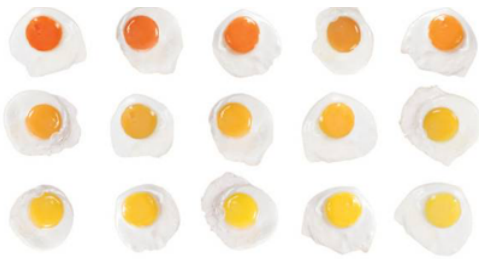
Spirulina consists of **60-70%** protein

Wheat, Australia's dominant source of protein in poultry diets contains **13.0%** protein

The amount of protein consumed by a laying hen, has significant effect on the **size** and **number of eggs** laid. Supplementing microalgaes enriched in protein, will allow the Australian poultry industry to **improve productivity**, thus contributing to the increasing revenue of the agricultural industry.

Carotenoids in Chlorella

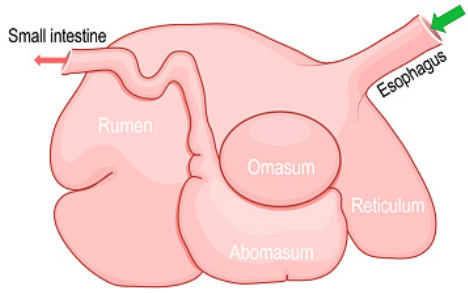
Carotenoids: pigments responsible for the yellow/orange colours present in foods such as pumpkin, egg yolks and carrots.



Over **200** carotenoids can be found in microalgeas, each with great **nutritional** and **antioxidant properties**. Chlorella, which is especially rich in carotenoids, when fed to laying hens causes **thickened egg shells** and **darker yolks**. In recent years, the preference for the colour of egg yolk has shifted from golden yellows to darker yellows. By supplementing microalgeas enriched with carotenoids into diets of hens, the Australian poultry industry can **accommodate** this change in preference and hence can **increase sales** of poultry products.

BENEFITS IN DAIRY

The Dilemma



Before food enters the reticulum of a cow, it passes through the rumen. The rumen contains enzymes that **partially break down some components** into simpler forms for absorption. For example, unsaturated fatty acid chains are broken down into short chain saturated fatty acids.

Subsequently, the **undesired fatty acids** (FA) **are absorbed**, instead of unsaturated FA chains. To avoid this, **coated microalgae** is recommended to **minimise the effects** of **bio-hydrogenation** in the lumen to allow the desired FAs to reach the mammary glands. This will provide far **greater nutritional value** compared to current grasses, crops and uncoated grains that are traditionally fed to dairy cows that lack unsaturated fatty acids.

According to a study by Hamed Safafar in 2015, milk **quality is influenced by type and abundance of fatty acids** consumed by dairy cows.

By coating microalgae, farmers could **significantly improve** the quality of their milk, thus potentially **boosting sales** of dairy products. .

IMPROVING MEAT QUALITY

Chlorella and Spirulina contain **high amounts of omega-3 fatty acids**, which are essential for livestock, as they cannot synthesise fatty acids. High intake will **promote cell growth** and **brain function** as well as:

Mixing pig feeds with Chlorella and/or Spirulina species produced meat with **well-balanced lipid profiles**

A study by Nieves Núñez-Sánchez, concluded that supplementing microalgae into the diets of lambs, caused higher concentrations of **polyunsaturated FAs** in meat, with **no negative impacts on growth**.

In a study by Toyomizu, it was reported that supplementing Spirulina at 4% & 8% into standard feeds of broilers allowed **yellowing of muscles**, fat, liver and skin. It did not affect growth, but these benefits are valued in the commercial meat market, potentially **boosting sales** of chicken.

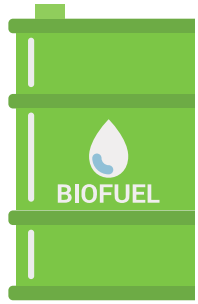
MANAGEMENT

Microalgae growth can be **grown and managed with ease** without having negative effects on the environment.

Microalgae **growing better in saltwater** means freshwater **can be used more in more important areas,** as it becomes more scarce with climate change.

The fact that it **grows so readily** on its own means that it does **not require labour intensive care or fertilisers,** so therefore it is **cheaper** to manage than a variety of crops.

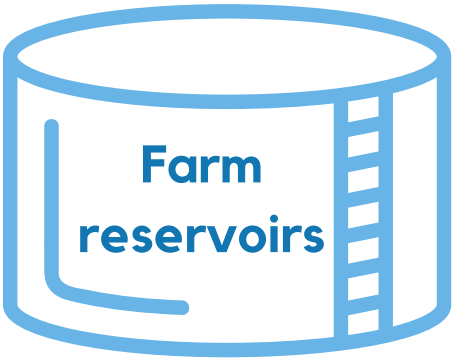
With increased research, microalgae can be used as a **sustainable biofuel**, allowing it to replace fossil fuel. This could be a useful **power source for farmers**, so that they can power other areas of the farm.



How would we grow it?

*THE POTENTIAL FOR **COMMERCIAL ALGAE PRODUCTION** IS EXPECTED TO COME FROM GROWTH IN TRANSLUCENT TUBES OR CONTAINERS CALLED **PHOTOBIOREACTORS** OR OPEN OCEAN **ALGAE BLOOM HARVESTING***

https://www.bioenergyconsult.com/algal-biomass/



Existing reservoirs can be used for microalgae growth, resulting in **decreased use of petrol powered equipment** to remove existing habitats for farming and for harvesting crops. Microalgae also help **purify this water and add valuable nutrients.**

Salinity in Australia is a growing issue and therefore existing **waters contaminated with high salinity** can be used productively to grow microalgae, instead of being wasted space.

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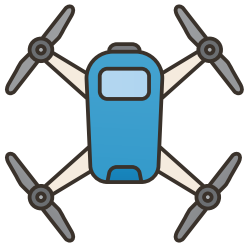
Microalgae can be **grown on fish farms.** This is an adequate location for growth and additionally, microalgae cleans the water and **improve the quality of fish** produced, due to the nutrients in microalgae.

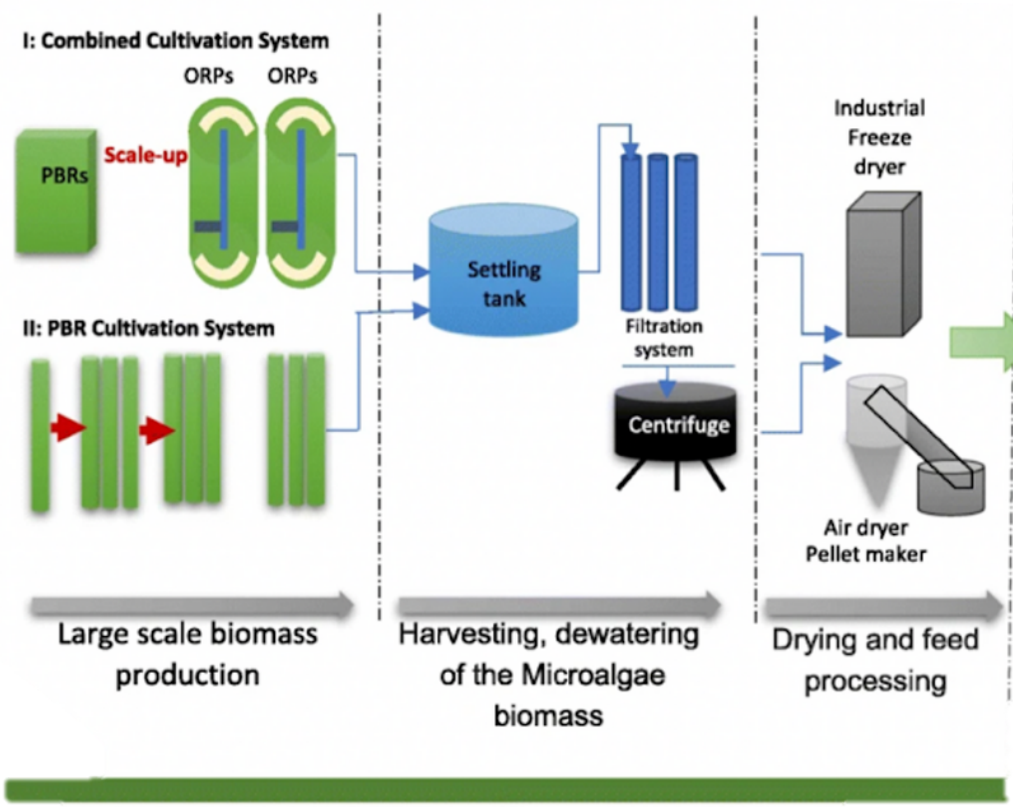
Photobioreactors can also be used, however, this would take up existing land and increase power consumption which is **less sutainable**.

Technology



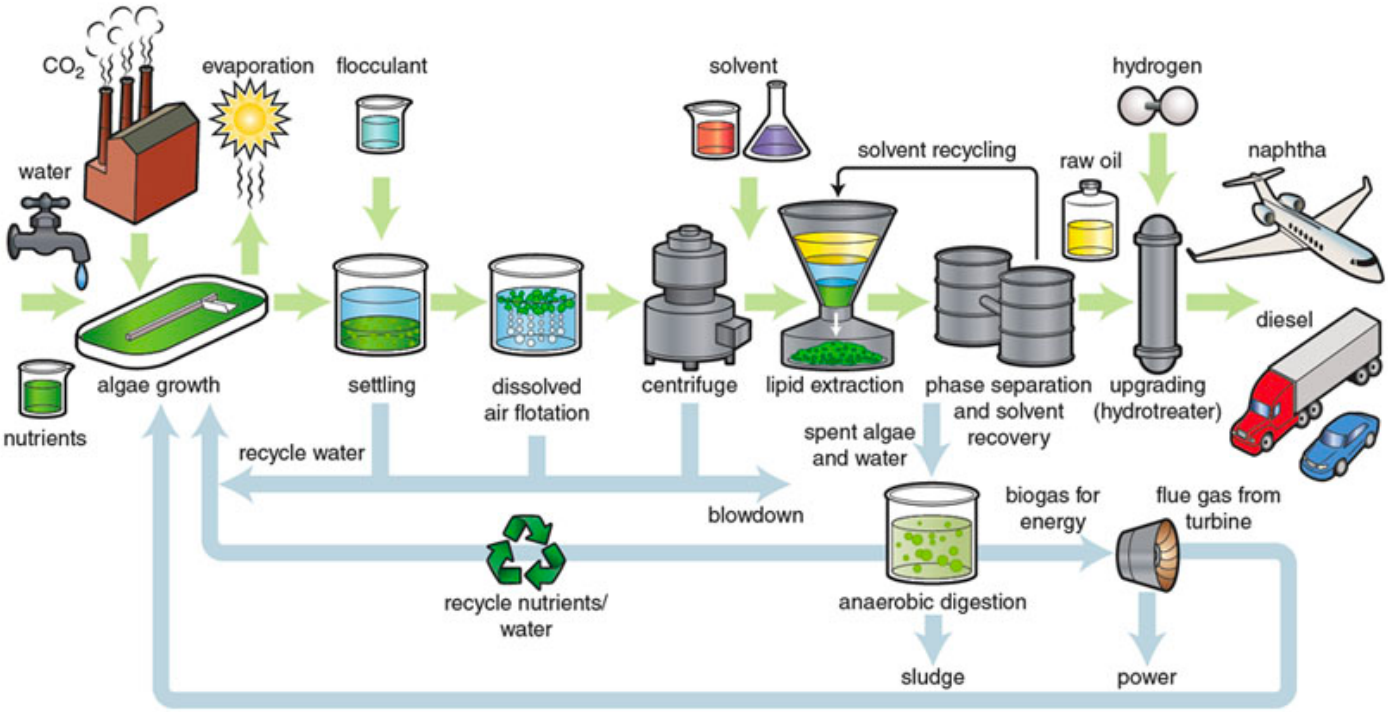
Drone AI technology with hyperspectral cameras can be implemented to assist farmers in **remotely monitoring microalgae growth** with ease, so they can spend time managing other areas of the farm. It could be programmed to relay growth status to their devices so farmers **know when to harvest**.

The process of **processing microalgae needs to be researched more**, but currently, the technology needed to transform microalgae into, for example, livestock feed, is not too extensive and has the potential to be **easily be managed** by farmers.



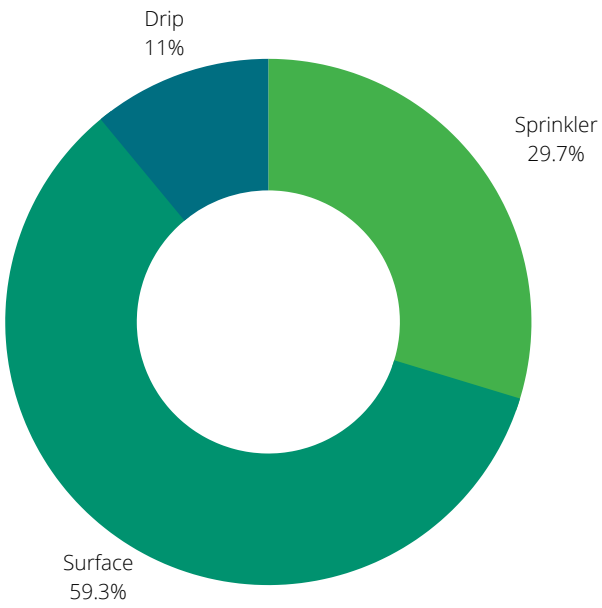
Technology involved in microalgae processing

In terms of processing algae for other uses, such as **biofuel**, additional technologies and equipment are necessary, however, it is not extremely complicated and **very achievable.**

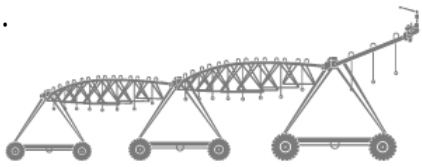


Advancements in Irrigation

Historically Australian irrigation methods have been inefficient. **Over half of irrigated lands** in Australia use surface irrigation which has a water application **efficiency of just 60%**



The next most prevalent irrigation methods are sprinkler and drip, both with water application efficiency of over 90%, **some exceeding 98%.** Furthermore these methods can double the crop yielded from a single field.



Sprinkler irrigation provides an easy and effective route for applying liquid-based fertilisers on a large scale. By irrigating land with water that algae have been grown in, crops will see **better**, **more leafy** growth, ultimately resulting in a **better harvest**.

An industry-wide conversion to more effective and efficient irrigation methods could save upwards of **1800 GL of water**. **That's a 25% decrease in water usage!**

Technology in Irrigation

As with algae, **quadcopter drones and moisture probes** can be used to monitor specific crop growth and identify problem areas such as water pooling. **AI technology** can then modify irrigation parameters in real-time to **increase crop efficiency.**

Emerging technologies such as project Xaver from FENDT present a **new and more efficient method for planting crops.**

https://www.fendt.com/int/xaver

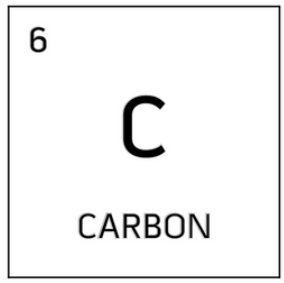
Xaver holds many advantages over traditional farming methods. Xaver's:

- **Lower capital costs** free up vital capital for projects such as irrigation and algae ponds.
- **Lower maintenance overheads** allows for more money to be spent on staff salaries increasing productivity.
- **Lighter body** reduces impact on soil.
- **Reduces man-hours** required to plant fields.

Many new and exciting **autonomous technologies** are emerging within the agricultural sector. By taking advantage of these new technologies Australia will be well on the way to meeting its 2030 goals.

Soil Managment

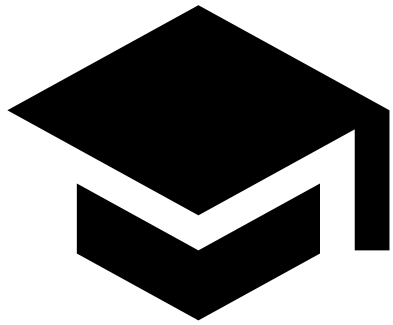
Organic carbon in soil is the **basis of fertility** and is a part of a soils organic matter



However Decades of **mismanaging** and **exploiting** soils has lead to **critically low carbon levels** in a majority of Australian soils.

Low carbon levels can be **easily managed** through specific crop rotations and management of erosion. These facts have been known for almost a century, however not having knowledge of this key concept has been a severe limiter for most farmers.

To combat this we suggest the incentivisation of courses that educate farmers on the most effective and efficient farming practices. So that farmers across Australia can more **sustainably create higher yields** from their existing fields, ultimately pushing Australia closer to 100bn by 2030.

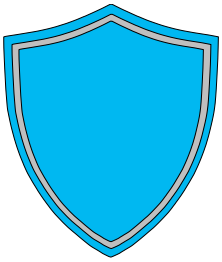


Genetic Modification and Breeding Programs

Traditional crops such as barley, wheat and cotton contribute substantially to Australia's agricultural exports, to expand this section of Australia's economy we suggest **investments in breeding programs** such as CSIRO's cotton breeding program

For every **$1** invested in CSIRO's cotton program

an **$80** benefit is seen within the industry



Specifically bred crops are:

- Able to produce higher yields
- More resistant to the hostile Australian climate
- Resistant to pests and insects.

Widespread adoption of CSIRO varieties in Australia **reduced insecticide use by 85% and cut herbicide use by 52%**

We believe that an increase in funding to successful breeding programs such as CSIRO's cotton program would produce an overall uptick in Australia's agricultural production.

Microalgae could be **genetically modified** to enrich water with nutrients to aid the growth of certain crops through irrigation. This **increases crop quality** and embeds further nutrients into crops grown for **human consumption.**

MIRCOALGAE IMPLEMENTATION INTO AUSTRALIAN AGRICULTURE

Due to the **vast environmental and economic benefits** of microalgae, the crop is clearly a great investment. Therefore, in order to get a head start on the **crop of the future**, the Australian government should **invest in research** to advance this field and **assist and encourage farmers** to cultivate their own **microalgae crops.**

This could be achieved through...

- **Low-Interest Loans** (or grants) to cover establishment costs of algae ponds and more efficient irrigation methods.
- Development of **infrastructures** such as the securing of new markets and breeding programs to increase the scalability of microalgae overall decreasing the cost to produce.
- The Australian Government could **provide training and information** on the best ways to farm microalgae
- Farms could purchase **microalgae processing infrastructure using** government stimulus money and used it to create a variety of algae products.

CONCLUSION

Microalgae is a **sustainable** crop that does not take up precious land and freshwater, a **benefit to livestock** health, and enriches **food for human** consumption. Paired with effective forms of **irrigation, genetic crop modifications, and new technologies**, the Australian **agricultural industry can be revolutionized** and vastly benefitted, keeping it on track to reach

$100B by 2030.