ALPHA FARM

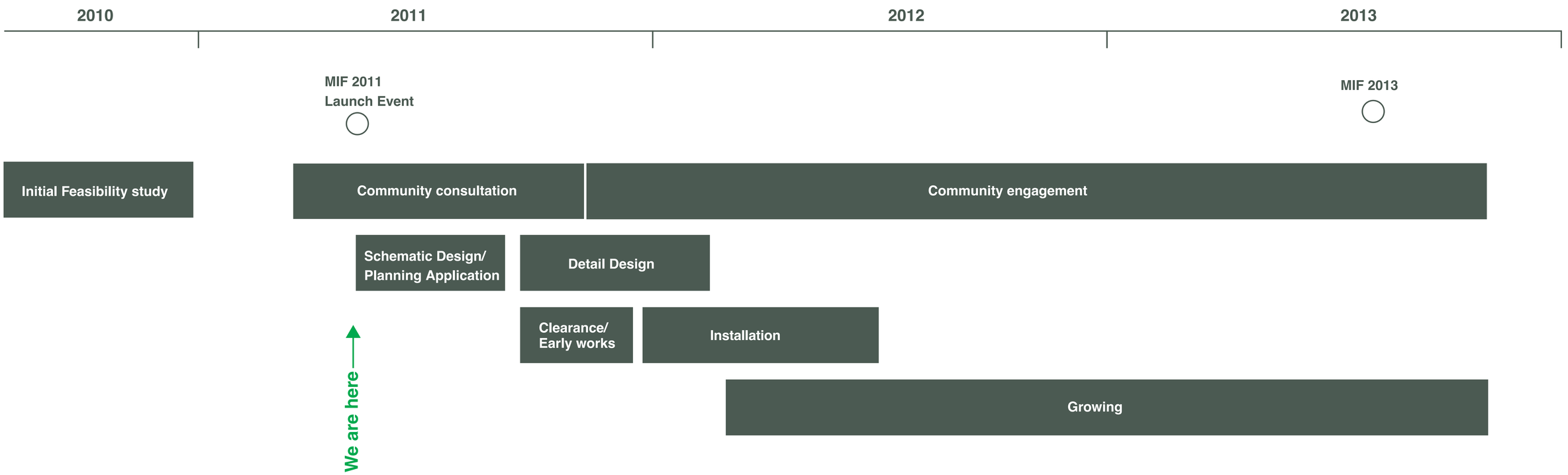
MANCHESTER INTERNATIONAL FESTIVAL

Every day, the planet has 219,000 more people to feed. By the year 2050, it is estimated that nearly 80% of the world's population will live in urban centres. Bringing farming to the city could be a viable and innovative solution.

With Alpha Farm we plan to explore how to retrofit redundant, empty city buildings to grow food – using pioneering new technologies such as aquaponics, hydroponics and aeroponics to turn a disused, eight storey office block in Wythenshawe into a productive food hub.

What we learn in this building could revolutionise the way the world's population could be fed. We will be learning as we go, seeing which farming methods work the best, what crops can be grown and how to get the community involved.

Launching at MIF 2011 and culminating at MIF 2013, this project is deliberately experimental. Exactly where it will take us is the really exciting bit…



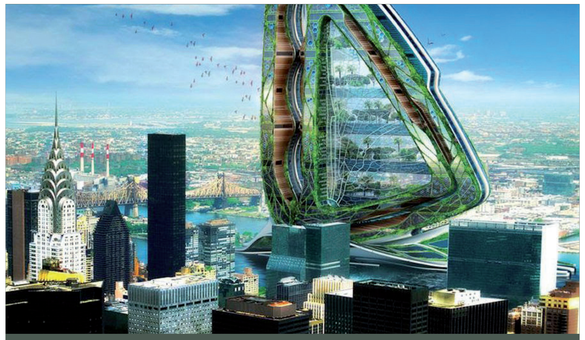
The story so far...

ALPHA FARM

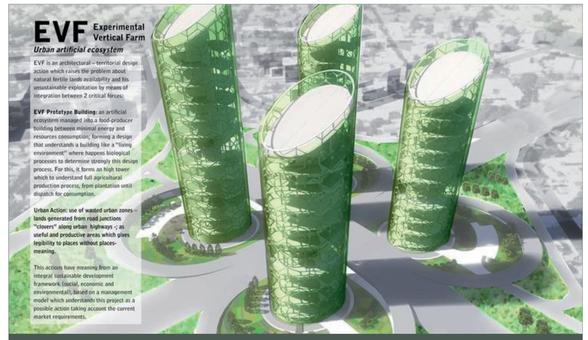
Utopian concepts

The Harvest Green Vertical Farm
Vancouver - 2009 - Romses Architects

Forwarding Dallas
Dallas - 2009 - Atelier Data & MOOV



Dragonfly Vertical Farm
NYC Roosevelt Island - 2009 - Vincent Callebaut



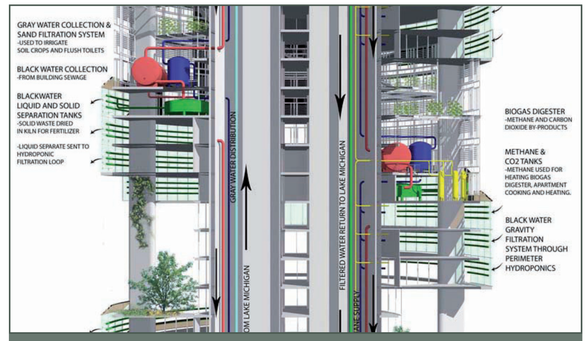
Experimental Vertical Farm
Santiago - 2009 - Claudio Palavecino Llanos

Components of a vertical farm

Verticrop:
a Valcent product used in Paignton Zoo, UK

Light:
VF - Type O.2 - Australia Olivier Foster

Combining aquaculture and horticulture:
The ABLE project - Wakefield



Sewage/waste reuse:
The Living Skyscraper Chicago - Blake Kurasek

Retrofit

The Plant - Chicago - 2010
Chicago Sustainable Manufacturing Ceter/IIT

FARM: Shop
London - 2010 - Something & Son

Aquaponic growing system
Milwaukee - 2009 - Sweet Water Organics

Heritage

A space-saving sensation at the International Green Week Berlin - Berlin - 1966

Technical Challenges

Our aspiration is to make Alpha Farm sustainable, creating a natural, symbiotic system where outputs from one part of the farm become the inputs to the next.

In designing the farm our team is looking to:

- minimise energy use
- maximise opportunities for symbiotic relationships within the building
- reduce, where possible, use of man-made nutrients and resources and the export of waste.

Growing Systems

We will test a combination of different growing systems, including:

- **Horticulture** – Traditional soil based growing
- **Hydroponics** – A common form of high yield growing in which plants are grown without soil, in an artificial medium
- **Aquaponics** – A system that combines aquaculture with hydroponics in a symbiotic environment
- **Aeroponics** – Developed by NASA, plant roots are suspended in the air and sprayed with nutrient rich moisture

Alongside the energy and nutrient flows there is the need to develop a series of control systems to monitor and control O_2/CO_2 levels, air and root temperature, moisture and humidity levels, light levels, nutrient levels and energy.

Nutrients and Water

- What symbiotic relationships can we develop within the farm?
- How can we recycle naturally obtained nutrients within the farm?
- How much nutrient will we need and where will we source this from?
- What will the water demand be and can we meet this by capturing water within the building footprint?

Energy

- How much natural light can we capture in the building?
- How much light do we need to grow healthy and nutritious plants?
- How can we minimise the energy demands of artificial lighting?
- What temperature range do we need to maintain within the building?
- What changes do we need to make to the building to achieve this?

Team

Feasibility of Alpha Farm is being explored for Manchester International Festival by a team of experts and designers including:

URBED – Lead Designers

The Centre for Sustainable Agriculture, Lancaster University – Plant science/Sustainable agriculture

Biomatrix – Nutrient/Water Flows

BP Institute, Cambridge University – Air/moisture movement

Buro Happold – Mechanical/Structural Engineering

Siemens – Technical Design and Support

Coral Grainger – Capital Relations

Debbie Ellen – Food Consultant

The project is supported by the Esmée Fairbairn Foundation

Growth

Our aspiration is that the Vertical Farm should produce fresh, healthy food in a sustainable way.

Key to this is understanding how plants grow and finding solutions to meet their needs such as:

- capturing and providing sufficient **quantity** of light
- providing correct **quality** and spectra of light required to produce healthy and nutritional produce
- controlling **temperature, pH, moisture**, and **oxygen** supply for healthy plant roots
- controlling the **length of the day** received (without the right daylength a plant may never produce fruit or grow healthily)

With innovative solutions to provide the right conditions we want to test whether it is possible to produce:

Fruit and vegetables Leafy: variety salad leaves, fruiting: sweet peppers, tomatoes and cucumbers, greens: broccoli, roots: carrots, parsnips and onions, fruit: strawberries and raspberries, others: mushrooms and various herbs

Meat, fish, eggs and beans
Free range chicken and eggs, fish: trout and perch, beans: broad and runner varieties, others: lentils, barley, pulses.

Bread, rice, potatoes and pasta Smaller potato varieties.

Light

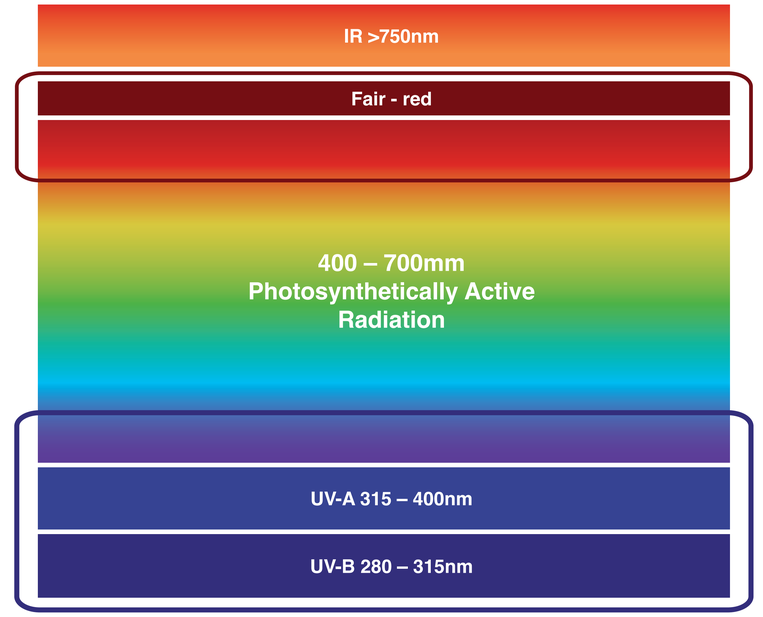
Plant growth depends not just on the quantity of light but on the quality. This means we need to think about lighting in a completely different way.

- Plants don't react to, and in fact don't need, the same portion of the spectrum as humans do
- If plants don't receive the quality of light they need they will not produce healthy or nutritional produce
- Taste and nutritional value are also linked to plants' response to sunlight – for example, anti-oxidants are produced in response to UVB. Providing the right type of light is critical
- Plants also react to the length of the day – scientists call this 'photoperiodicity'. Changes in the length of the day trigger different responses. Without the right daylength a plant may never produce fruit or it may not grow in a healthy way
- Different plants have different responses to the length of the day, reflecting where they would have grown naturally in the wild

Roots

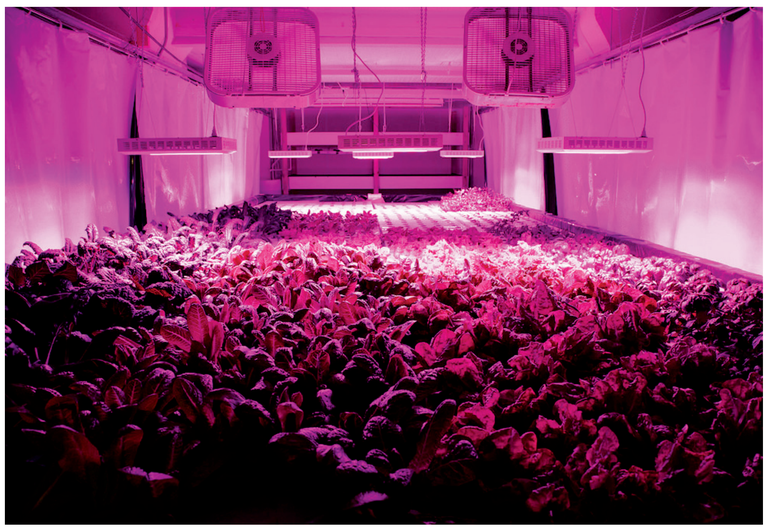
Conditions around plant roots influence their ability to take up nutrients:

- Temperature, pH, moisture and oxygen influence how well roots work
- Provided roots are at the right temperature, plants can still grow in air temperature that is too hot or cold
- Solutions to this include heating the soil and/or nutrient rich water, particularly in the case of hydroponic or aeroponic systems



Above: Plants need and respond to specific parts of the light spectrum, as highlighted

Below: LEDs provide specific wavelengths required for plant growth



Energy

The vertical farm will not be sustainable if it uses more fossil fuel energy than conventional agriculture.

Our aim is to minimise the energy required for the farm's growing systems to work. We can achieve this through careful attention to lighting and heating and by selecting crops according to the conditions in the building.

Heat

The building dates from the early 1970s and is poorly insulated. Full scale improvements, and heating of the whole space, would be expensive.

As different plants respond to specific growing conditions triggering the growth of the leaves, fruit and roots, we will try and meet their needs by warming plants directly – using lighting banks and warming liquid nutrients, roots and soil.

To support this energy requirement sustainably, we are exploring how much of the energy needs could be provided by solar thermal collectors on the roof and a biomass (woodfuel) boiler.

Humidity

In summer the growing areas will produce high levels of humidity. Managing this could, using conventional techniques, require a lot of electricity. Techniques to minimise electricity use include:

- Natural circulation of the air to transfer the humidity to other growing areas
- Removing the humidity using cold water or 'heat pipe' units

Air

We know that we will need to circulate air between the different growing areas, and between floors, in order to manage humidity, oxygen and carbon dioxide levels.

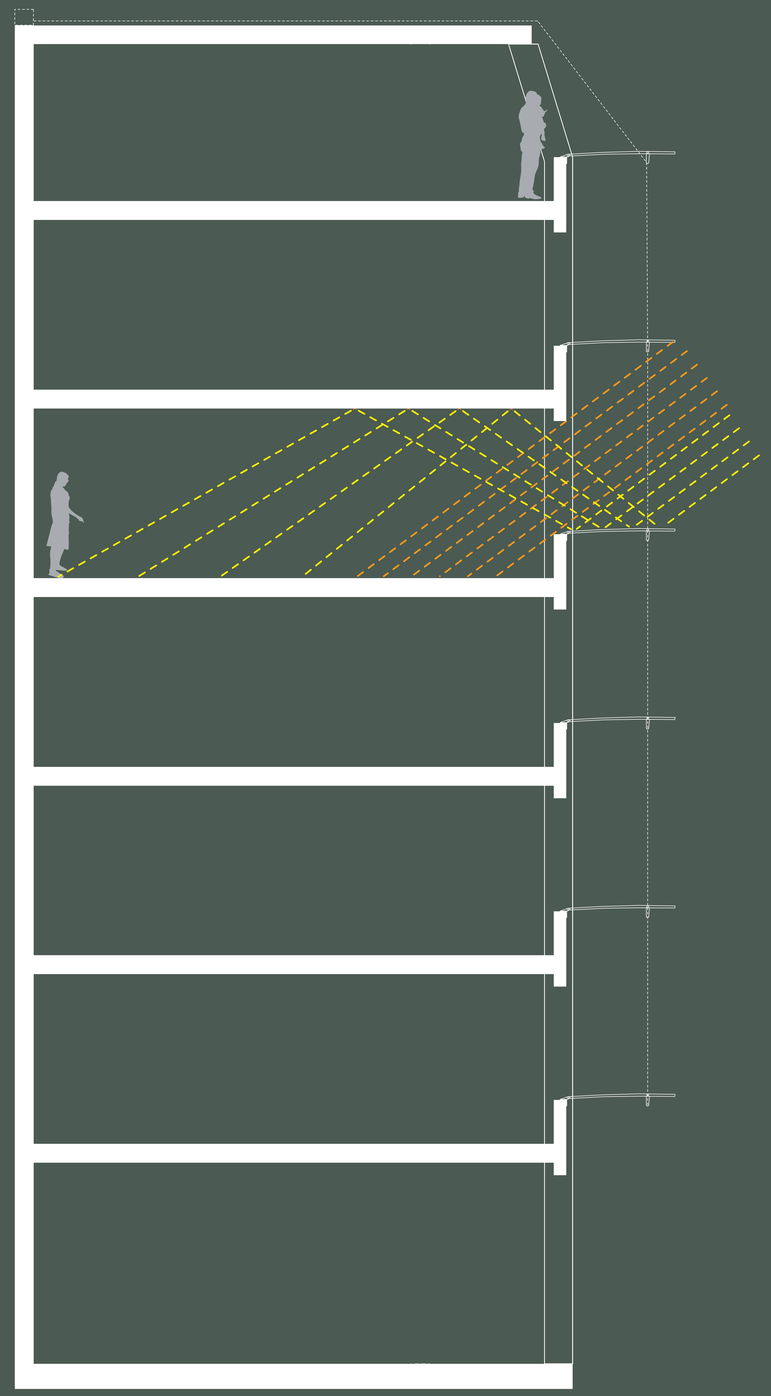
Moving large volumes of air could require large amounts of electricity for fans. We could minimise this through:

- Passive forms of ventilation that rely on the buoyancy of warm, moist air

Light

Availability of the right amount of good quality, evenly distributed daylight is fundamental:

- We are looking to maximise daylight penetration from 2-3 metres to 7-8 metres using a system of mirrors to reflect light deeper into the building (see right)
- Where there is not enough daylight we will need the most energy efficient artificial lighting (for example Light Emitting Diodes) to provide the right spectrum of light for plants. These can also be dimmed, allowing a plant's 'day length' to be controlled.



Nutrients

Modern industrial agriculture, horticulture and aquaculture is almost entirely dependent on fertilisers manufactured from fossil fuels or unsustainable sources of protein. A key challenge is to create a more sustainable system for Alpha Farm by integrating different growing systems, recycling nutrients and sourcing nutrients from local organic waste:

Nutrient production

Some growing systems could produce food and fertiliser for the rest of farm, for example:

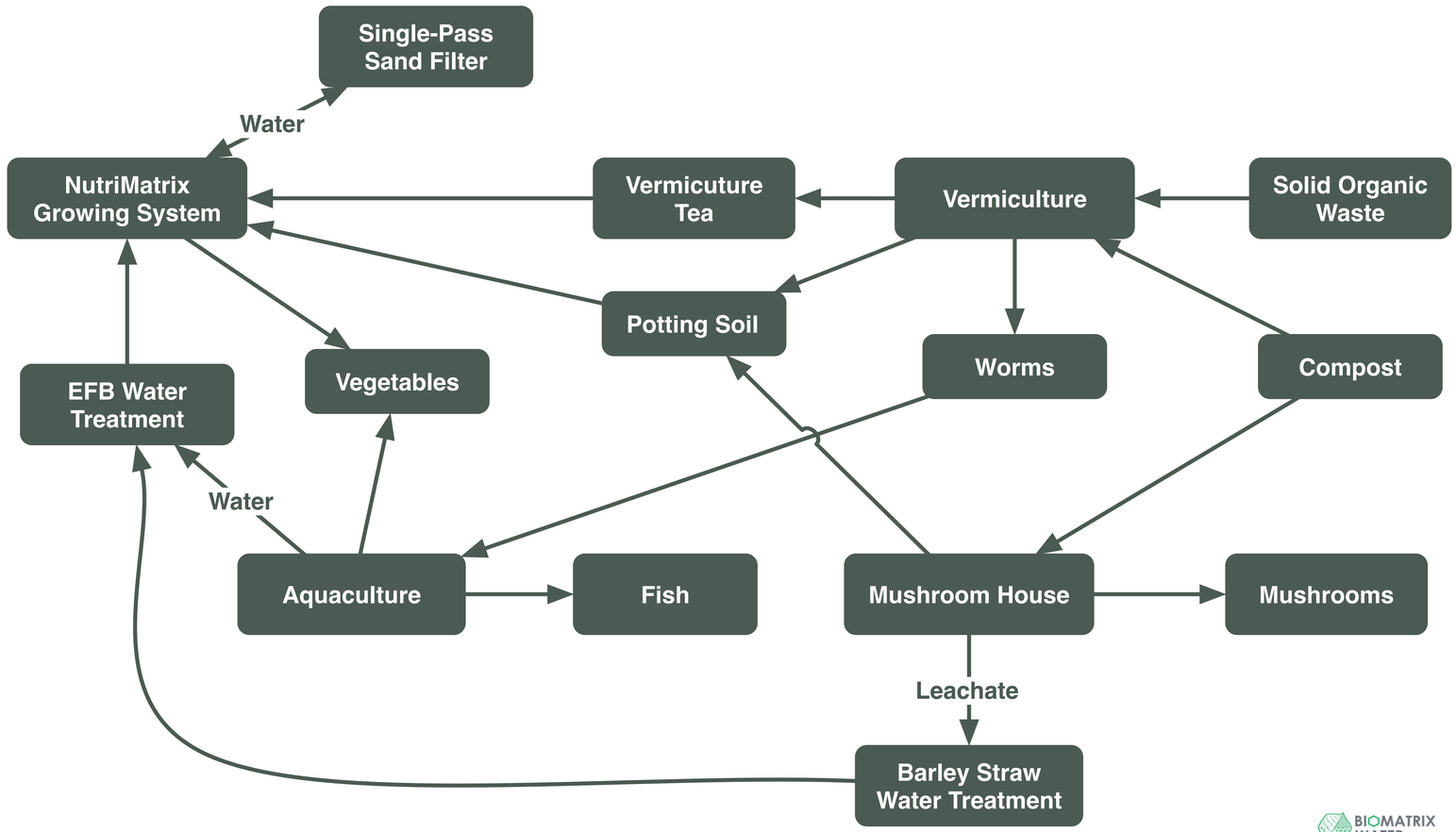
- Worms, using vermiculture techniques, could feed fish in an aquaculture growing system
- Nitrogen rich waste from fish could be used, following treatment, as fertiliser for plants. Fungi also produce a nutrient rich leachate
- Excess oxygen produced by plants could enhance mushroom growing
- Carbon dioxide produced by mushrooms could enhance other plant growth

Sourcing organic nutrients

Local sources of organic waste, for example composted household waste or liquid digestate from nearby sewage works, could supply new nutrients for the farm if made safe for food production.

Collecting and recirculating water

To sustainably source the water required for the farm we will aim to: conserve, treat and recirculate water to minimise mains water use, and, to collect and treat rainwater, using filters and Ultraviolet light.



Above: Growing system schematic