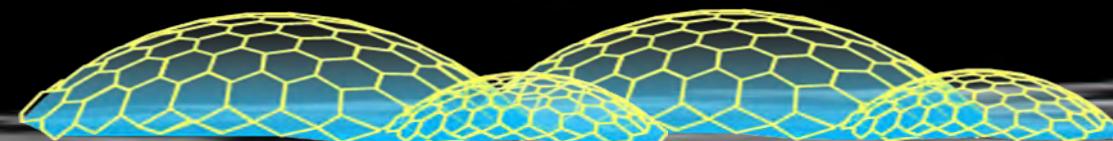


# The Basics of Farming in Space



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<http://www.spacefarms.info>

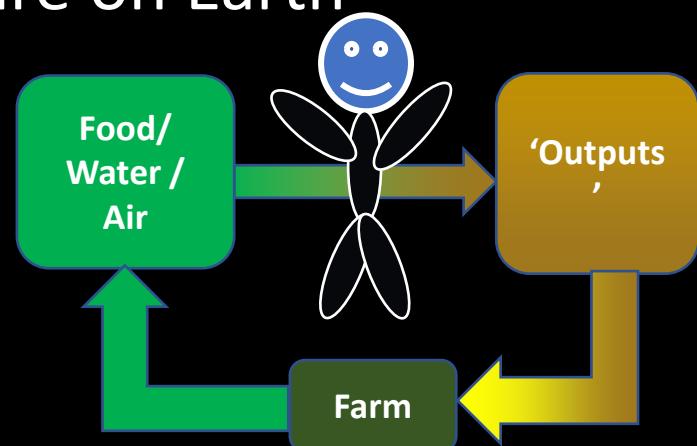


# Overview: Key Questions

- What is a Space Farm? Why would we need one? Is it like the farms here?
- How does my Space Farm change as I go from having a Space Outpost to having a permanent space settlement?
- What machines will I need? Do we have them now?
- How big is a space farm?
- What does a menu look like?

# What is a Space Farm? Why do I need one?

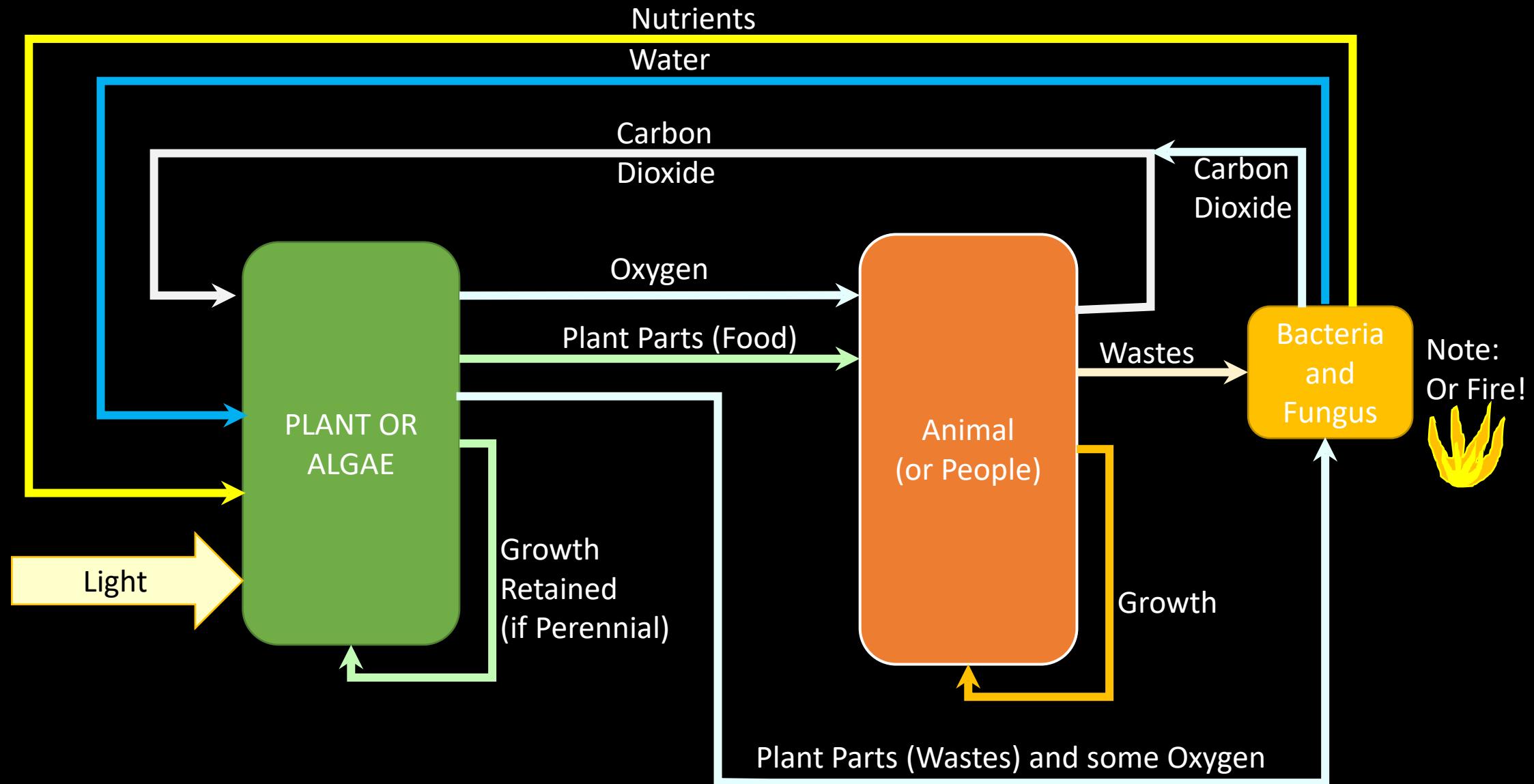
- Space Farm: the way food is grown by recycling air, wastes, and water.
- Space Farms use a combination of living things and machines to as efficiently as possible convert what comes out (of us) into the food, oxygen, and water we need.
- Why not just live off food sent from other places? In short, you could but then you are always paying to ship food in, and if the space settlement is far away you may not get food, even preserved food, quickly
- Why waste the wastes? A space farm works just like nature on Earth to recycle mass using energy.



# Wastes and Earth Farms?

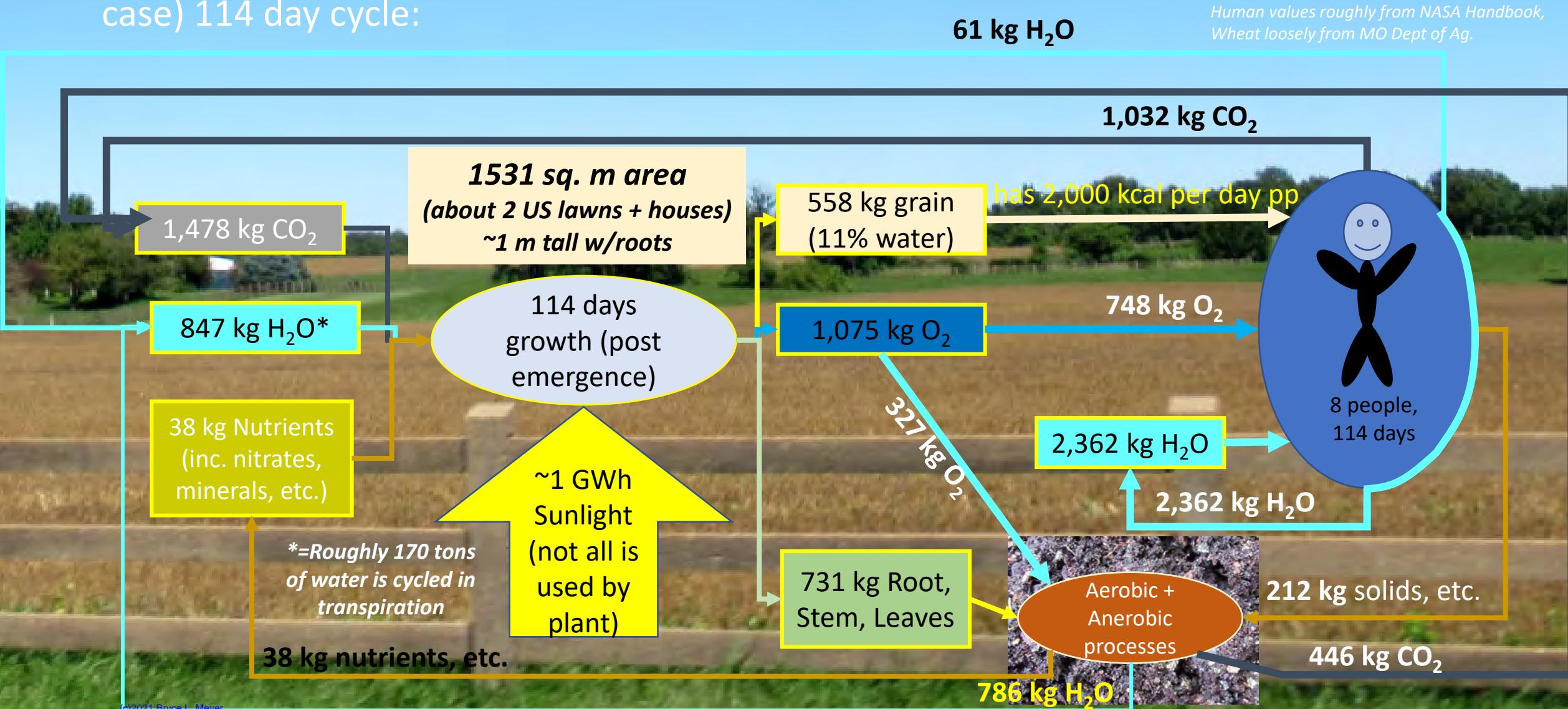
- On Earth, plants (or algae) take in energy from the sun, and carbon dioxide from the air, and water and nutrients from the ground.
- We, or other animals, eat the plants, and the animals release carbon dioxide and water in breath, and water and materials from urine and feces
- Bacteria break down the wastes to release more carbon dioxide, water , and nutrient, which plants can then use.
- An Earth farm does something similar using the same mechanisms...

# A bit of simplified chemistry...

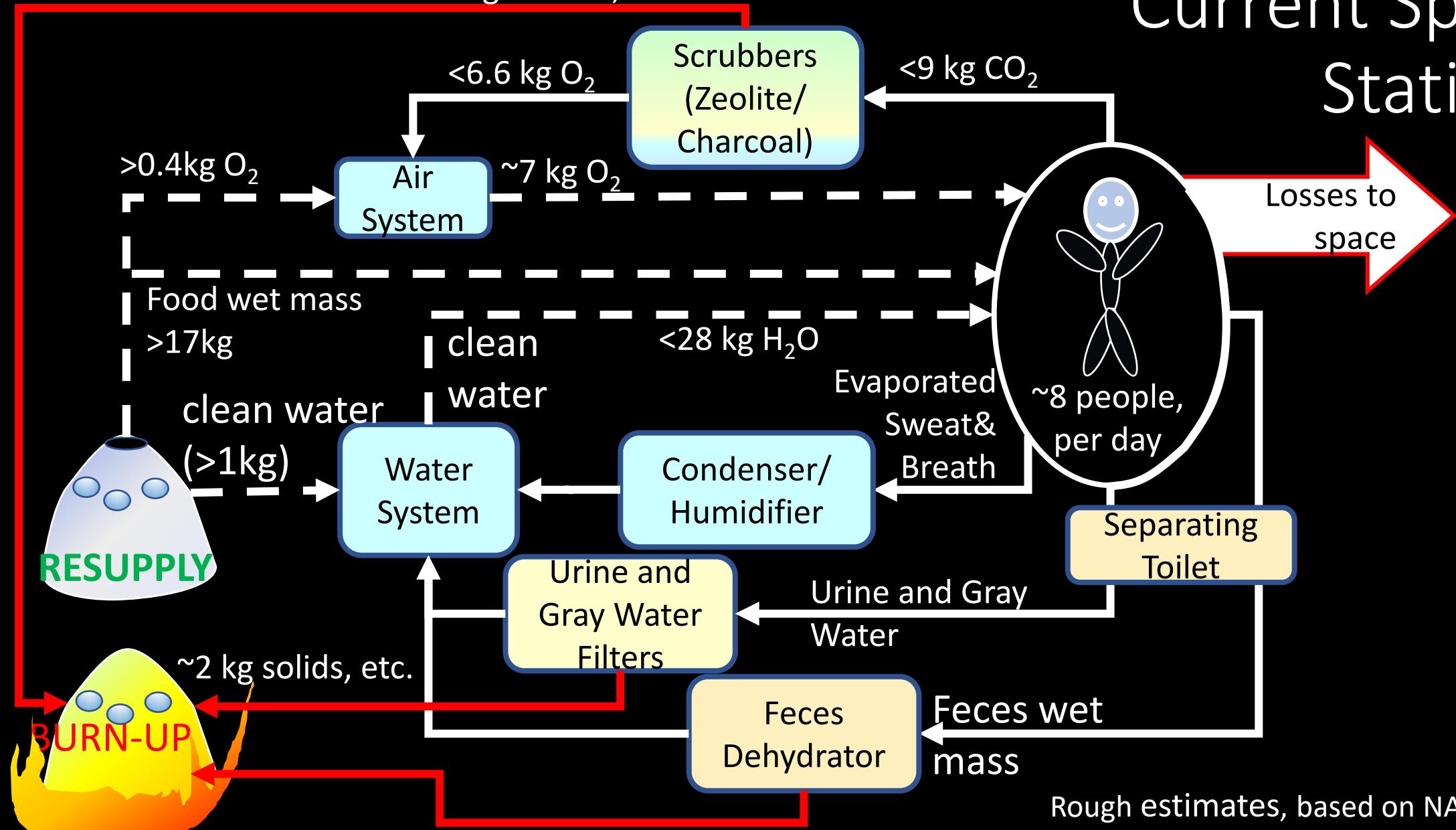


# Food for 8: Earth Analogy (A bit technical...)

- On Earth, Farms are soil based and take in things we take for granted:
  - Assume all 8 settlers just eat wheat (“man cannot live on bread alone...” literally in this case) 114 day cycle:



# Current Space Stations

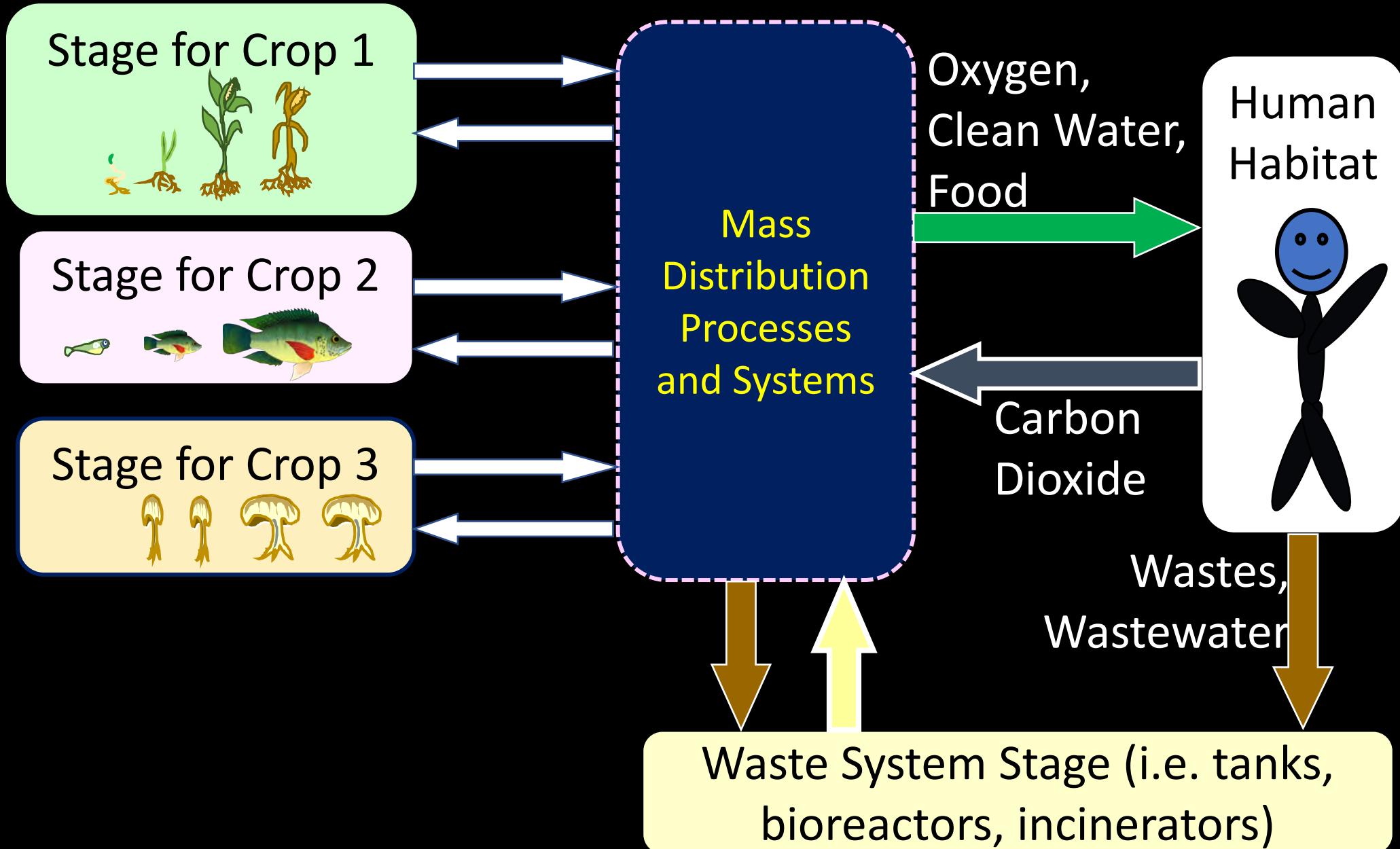


# Farm Concept: Stages

## Farm Living Components (Stages):

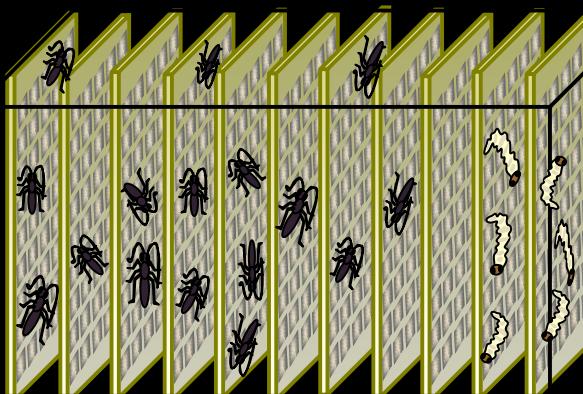
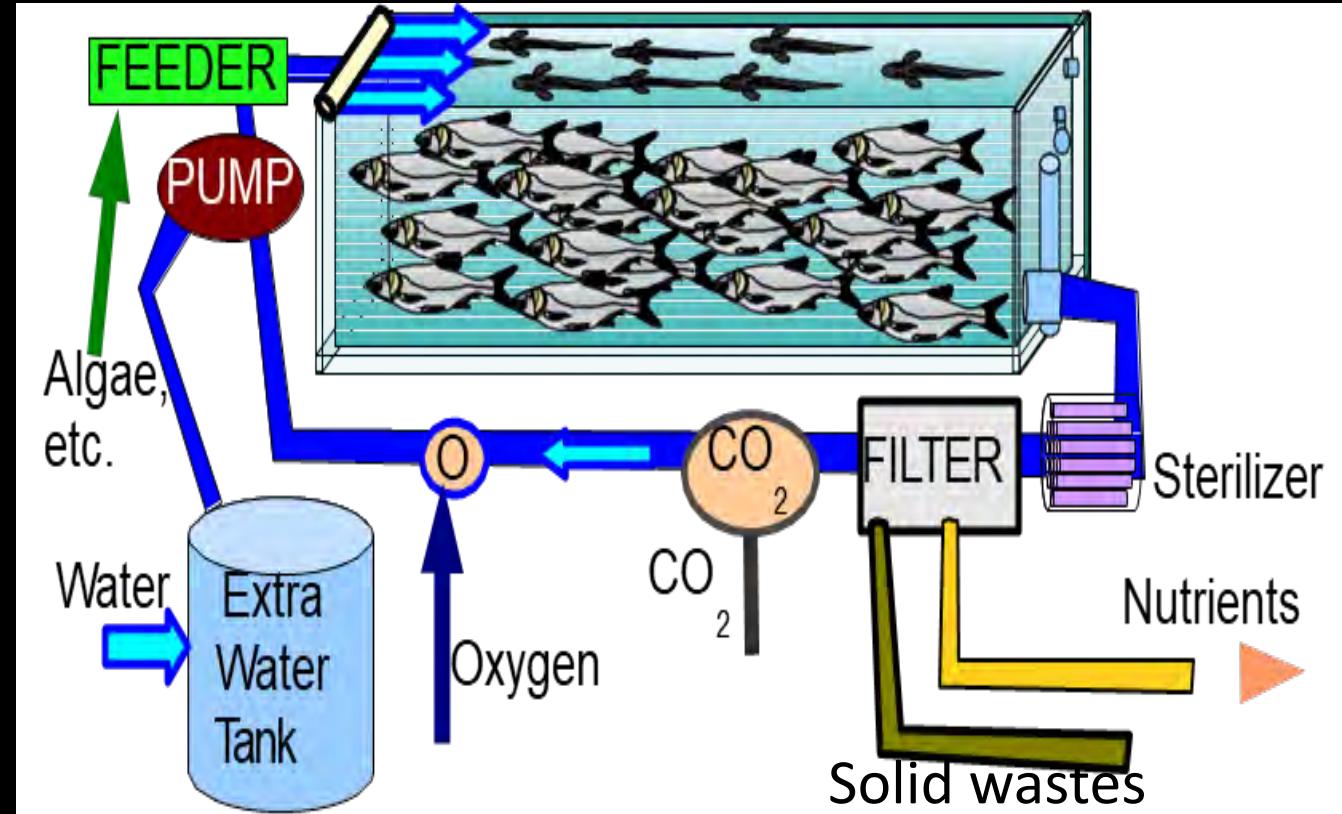
- Aquatic: Fish or shrimp in tanks
- 'Hydroponic': Hydroponic/Aeroponic/Aquaponic beds lit by LED lights or sun
- Photobioreactors (Algae Reactors): Machines with lights and algae to recycle air and water and grow food for people or animals
- Bioreactors: Machines that use Bacteria and Fungi to recycle wastes.  
**CONVERTS FIBER TO CARBON DIOXIDE!**
  - Replaces what soil does.
  - Maybe Incinerators too.

Farm Stages and the Human Habitat are linked to make an artificial ecosystem cycle.

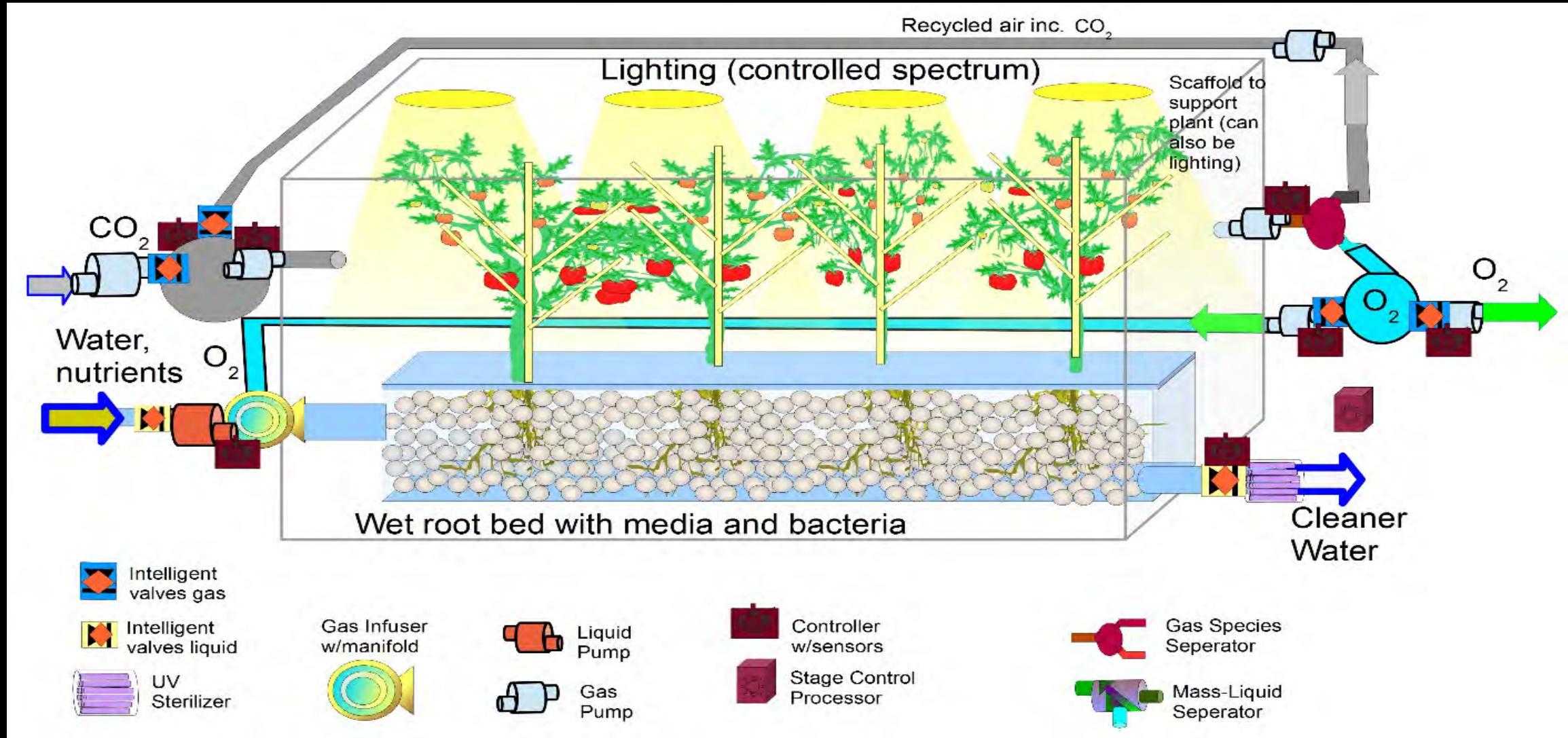


# Animal Stages: Fish, etc.

- Aquatic Organisms are very efficient at producing fresh protein...especially shrimp, and some fish
- They can be fed algae ideally
- Even if not eaten, can make the farm more efficient...fish wastes make good fertilizer: Aquaponics.

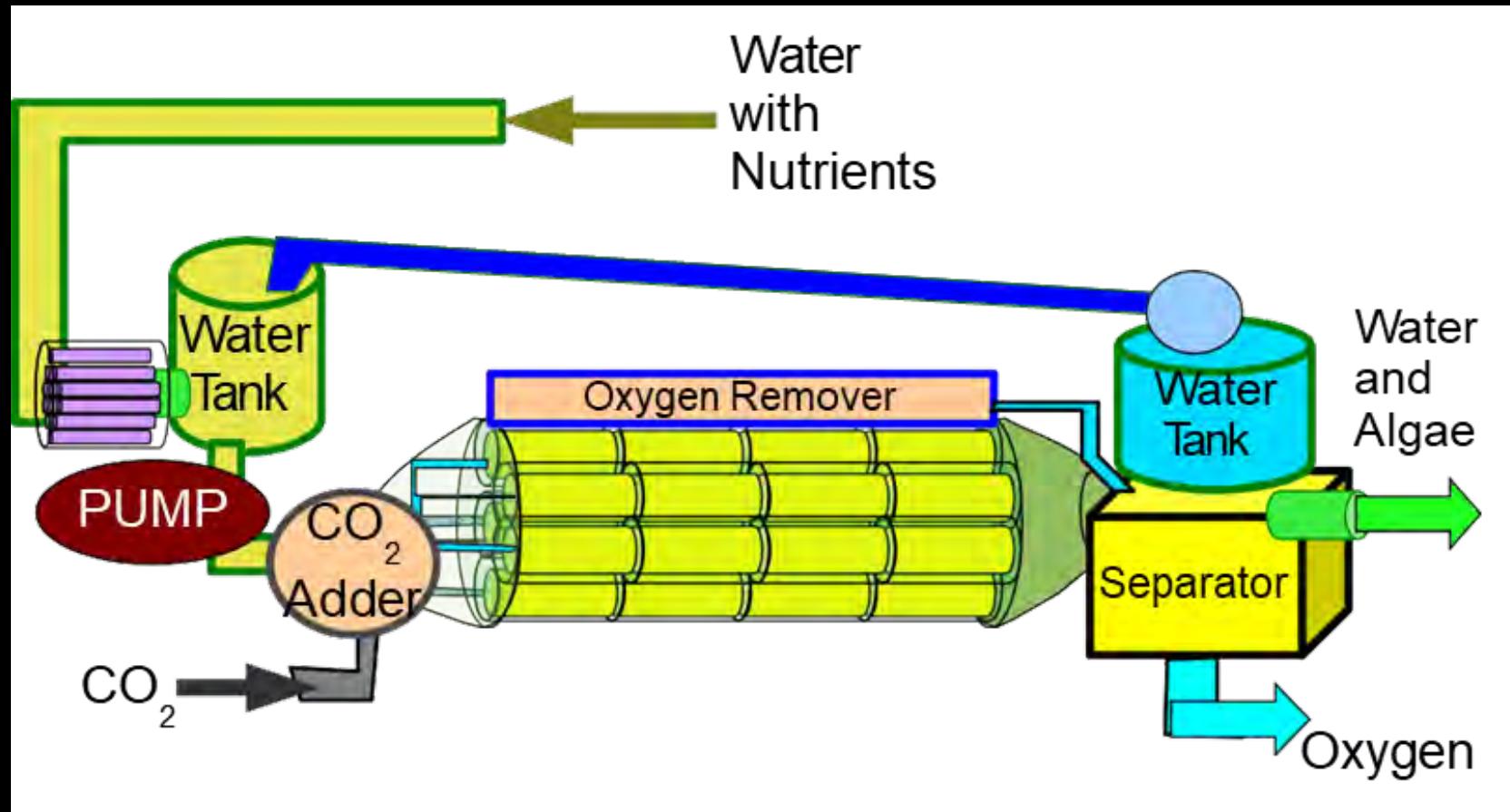


# Hydroponics and Aeroponics: One example

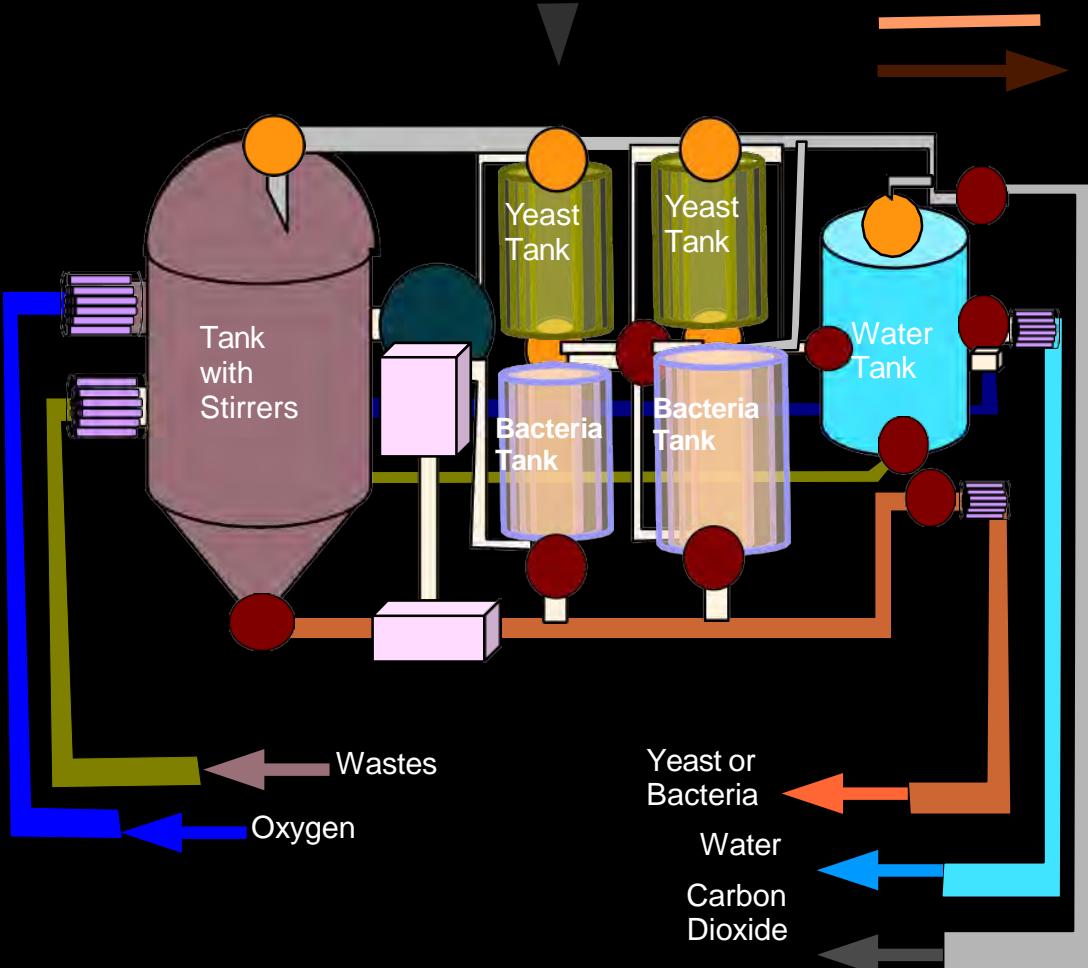


# Photobioreactors: Making a slime vat...

- Can be as simple as a vat with stirrers and lights, or as complex as you need...common on Earth for Biofuels and Food Production



# Bioreactors: For Food, Recycling and Beer...One example



- You are already familiar with Bioreactors:
  - Soil
  - Your Intestines
  - Wine and Beer fermenters
  - Sceptic and Waste Management systems
- Yeast Solids are very nutritious too!
- This is best an **AEROBIC** Reactor...

# Other Parts: Machinery to tie it together

- Systems:
  - Dirty Water: Moves liquid wastes from people and/or animals to the Bioreactor as needed.
  - Clean Water: Moves drinkable, fish-usable, and plant-usable water
  - Solid Wastes System: Moves solid waste to incinerator or bioreactor
  - Food and Feedstock: Moves human food and animal feed as needed
  - Gas Management: Moves Oxygen, Carbon Dioxide, and other gasses to animals, plants, photobioreactor, and bioreactor as required
  - Energy System: Takes energy from solar arrays, nuclear, or other sources to power machinery and lights.
  - Heat Management: Uses pipes, fins, pumps, and fans, to keep temperatures right where you need them
- These include: Tanks, Control Systems, valves, pumps, fans, generators, and batteries.

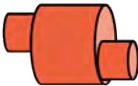
# A few of said machines....ALL ARE AVAILABLE NOW!



Intelligent valves:  
Combinations of  
variable valves and  
simple processors and  
sensors to control flow  
and direction



UV Sterilizer: Similar  
to current Pond/Pool  
Ultraviolet filters with  
multiple loops and  
sensors to assure  
sterile liquid/gas



Liquid Pump: A  
self priming  
pump to push  
liquids  
(increase  
pressure)



Gas Pump: A  
pump to push  
gases (increase  
pressure)



Reverse Osmosis  
Purifier: pushes liquid  
against a membrane  
to extract pure liquid  
(water) from a mixed  
liquid



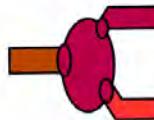
Controller w/sensor array:  
A complex set of routers,  
processors, and sensors  
that set conditions and  
control devices as directed  
by control software



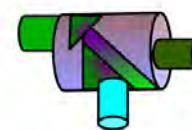
Agitator /Infuser: A mixing  
blade and hose  
arrangement to stir thick  
liquids and add gasses and  
liquids while stirring.



Stage Control Processor:  
A router-multi-processor  
computer programmed to  
optimize a stage (make  
and keep conditions ideal  
to convert inputs into  
outputs)



Gas Species  
Separator:  
Pulls out one kind of  
gas from a mix of  
gasses.



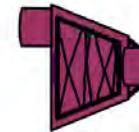
Mass-Liquid  
Separator: Pulls  
solids from a liquid  
mix.



Gas Extractor  
(from Liquid):  
extracts dissolved  
gasses from liquid.



Condenser:  
extracts  
liquid from a  
gas mix.



Macerating  
pump: takes  
coarse solids  
in liquid and  
mixes them  
into a fine  
mixed liquid



Gas Infuser w/Manifold:  
mixes gases into a  
liquid solution, then  
distributes the result into  
multiple pipes.



Complex Manifold  
Liquid Router: shuts  
liquids based on  
chemical  
composition.

# The more complex the farm, the better the menu!

- Early Space Farms might just be a waste tank, an incinerator, a condenser, hydroponics or aeroponics, and a photobioreactor, with 3d printers: Menu is Glop, Printed Glop, and a very few fresh veggies.
- Adding even a few other parts makes a better menu...adding a larger hydroponic set gets more veggies, but requires more initial water, and carbon dioxide...
- Adding some animals like fish, shrimp, or insects, help balance carbon dioxide, and add more to the menu...
- The problem in all space farms is carbon dioxide, not oxygen.
  - Fiber is hard to break down, and plants need lots of CO<sub>2</sub> to grow.
  - YOU DO NOT EXHALE ENOUGH CO<sub>2</sub> TO GROW ENOUGH PLANTS TO FEED YOURSELF!

# A complicated farm = Diverse Menu



# Herbs and Spices?

Most spice plants are great plants to grow in the habitat with people! They clean the air, can clean some water (i.e. wash water, not flushable water/wastes) Fit into corners, hallways, offices, etc.

Spice	Time to First Harvest (wiki)
Basil	75 days
Cilantro	30 days
Dill	90 days
Fennel	100 days
Mustard	95 days
Chives	60 days
Marigold (Candula)	70 days
Mint	90 days
Tarragon	60 days
Oregano	120 days
Cumin	120 days
Ginger	200 days
Serrano Peppers*	120 days
Paprika*	150 days
Saffron	180 days
Chili Peppers*	120 days
Coriander	100 days
Garlic	180 days
Turmeric	300 days
Thyme	1 year
Rosemary	1 year
Hops	2-3 Years
Coffee**	2-3 Years
Tea**	2-3 Years

\* = Same species as bell peppers, \*\* = large enough to require space and possibly a hydroponic stage, good for export!

# Today's Space Menu

- Fried Shrimp with algae strip salad, spiced with a mix of turmeric, thyme, etc.
- pseudo-Curry Shrimp and soy noodles
- Baked Fish with fennel and sage, and tomato/kelp salad with yeast flavoring.
- Tofu soup with algae power
- Other Sides: Spiced Soy-Rice Noodles, Edamame, Steamed Rice, Soy-Cheese Analog
- Drinks: Water, tomato juice, saki, beer, rice pseudo-Mexican horchata (no cinnamon :O( ), algae juice.
- Dessert: Rice Flour Ginger Muffins

*Will Improve as I add species!*

# Chicken, Eggs, Others?

As the settlement gets bigger: More plants get grown in soil versus hydroponics....More animals can be added, eventually chickens, insects, rodents...

Settlement Size	Chemical Processors	Photobioreactors	Aerobic/Aerobic Bioreactors	Hydroponic (substrate-less)	Hydroponic (w/substrates)	Soil Farm	Insect Farm	Aquatic Animal	Land Animal
8	X	X		X			X	(pets/grow-out only)	(Pets are a portion of a person...)
20	X	X	X	X	X		X	X	(pets only)
50		X	X	X	X		X	X	(pets only)
100		X	X	X	X		X	X	(pets only)
500		X	X	X	X		X	X	Rodents, maybe chickens
1,000		X	X	X	X	X	X	X	Rodents, Goats, Chickens
10,000		X	X	X	X	X	X	X	Large Animals

# Conclusion

- Space Farms are adaptations of farms on Earth, so that I don't have to ship up everything I need to live
- Space Farms are mass recyclers!
- Space Farms can also provide a better diet too!
- The bigger the settlement, the more complex the menu can become.
- All the machinery and species exist on Earth now.
- They are not much bigger than farms here.