

## Lunar Bamboo Greenhouse Questions and answers

I've been thinking of doing an aquaponic system which would involve having a tank underneath with a few fish to help produce natural fertilizers for the plants while also potentially being another source of food. Would that be something that would be good to peruse or is that something outside of what you're looking for?

I am open to the idea of aquaponic system and using fish unfortunately you are still going to be limited to the same volume. Besides fish you might also consider freshwater crawfish or other kinds of water bugs.

Also, I've been wondering how tall the green house would be. Height restrictions can play a major part in deciding which type of bamboo is possible to use and how best to grow it.

Since the structure is a hemisphere with a diameter of 20 ft, the height is 10ft in the middle. Because of the need for radiation and micrometeorite protection both for the crew and the plants, the shape is to help with preventing weak points in the structure both for keeping air in and the strength for supporting the regolith on top.

Would the greenhouse need to be strictly a spherical, dome shape, or could we change the shape of the greenhouse for more opportunities?

The shape is essentially a hemisphere. Part of the reasons are related to the inflation as well as the strength of the shape once the 3ft of regolith is added on top.

Would the power be supplied to the building already or will we have to think of a power source by ourselves?

The power will already be in the module but you could give direction of where you want outlets and if there are specific power requirements.

Are there other plants planned to accompany the bamboo, and if so, what are they?

You can help determine that. Some may be related to food production but is not the only concern. The main plants for you to worry about is the bamboo.

- What is the material that will be used for the greenhouse?

There will be several layers of cloth and flexible materials—kevlar and Beta cloth (a fiber glass material) on the out side, layers of mylar for insulation, urethane as a pressure bladder, and an inner scratch material. You should be able to find more details on the internet. Search inflatable space craft materials—the modules on the moon will be very similar.

Finally, how and where would the water be stored for the greenhouse?

Some water may be stored outside but some should be inside. You can help determine that internal storage location and quantity.

1. Are there any details on the material and structural supports of the inflatable module we are working in?

If you do a Google search on materials for inflatable modules, you should expect that those materials will be very similar to what we sent to the moon. There should not be other supports as the dome structure should be very strong.

2. Is the 20ft diameter we are given a measurement to the inside of the inflatable or the outside?

Assume that to be the inside dimension for the dome

3. Is the bamboo being grown from seeds or are they being sent up as shoots?

I would like to let you be the judge of that. It seems to me that it may be more valuable for us to send small shoots to start the growth, but I'm open to ideas.

4. What are the dimensions of the entrance to the module?

Good question. Let's assume each hatchway to be 48 in.<sup>2</sup>.

5. Can we put infrastructure (plumbing, electricity, etc...) underneath the floor or does it need to remain within the 20ft hemisphere?

There may be some that is in the walls and floor of the module, but there will be connections and cables inside as well

6. How much bamboo are we expected to be growing?

The purpose of the bamboo is to supplement the capabilities of the ECLSS racks, by removing carbon dioxide and providing carbon dioxide, but we don't expect it to take over the job of the ECLSS. I don't have a quantity that is required so I am depending on you to help determine how much to grow.

7. How much space do we need to allocate for other crops?

I'm not exactly sure. How about half. Again I am depending on you to help decide this.

A question regarding the ventilation system in the Greenhouse base. I've devised a diagram of a propeller system with the qualities of an air conditioner. However, we have no idea where that hot air will go. I thought that maybe there could be an insulation method that allows hot air to pass out the base, but any contact to the outside is highly dangerous. We would like your input on where the air would go, assuming there's plumbing underground with drainage holes that help with the ventilation.

This is a similar issue that we have on the space station. We can't vent hot air to the outside as that means we are losing air. This implies that we're going to have to have some kind of radiators that send heat without losing air.

If you look at a picture of the space station, you will see big large panels that are the solar panels and other sets of white panels that are the thermal radiators. The space station has a liquid cooling loop that circulates cold water to different cold plates in the space station. After the water is warmed up by being next to the electrical components, the water is circulated to a heat exchanger where the water is cooled again and recirculates inside the space station. As the water passes through the heat exchanger, the heat from the water is transferred to ammonia that circulates on the outside of the space station to the white thermal radiators.

Those thermal radiators eject heat only by radiation. Because space does not have air there is no convection like what we would use on earth. Therefore, it can only eject the heat by way of radiation.

I don't mean for you to have to design this thermal system for the lunar base. You should probably show a loop that goes outside somewhere to reject the heat and then comes back inside with cooler water.