Title :

Controlled Environment Agriculture for the Effective Growth of Plants in Indoor Farming

Full name of Speaker : Jocelyn F. Villaverde, PhD

Institution : Mapua University, Philippines

Project Title: Controlled Environment Agriculture for the Effective Growth of Plants in Indoor Farming

Background :

https://www.newstrail.com/climate-control-agriculture-market/

Controlled Environment Agriculture (CEA). This concept pertains to circumstances where crops are shielded from the extreme environmental conditions and have the capacity to manage, oversee, and regulate the microclimate of the cultivation area.

Project Title: Controlled Environment Agriculture for the Effective Growth of Plants in Indoor Farming

Background :

Strawberries can only withstand temperature decreases of 30°F, or -1.11°C

The threat of frost during Amihan season is high likely due to its elevated location.

Feb. 2, 2021, Atok farmers in Benguet province have experienced frost.

Targets:

To prevent these kind of losses, the researchers aim to replicate the normal environmental conditions in the province of Benguet, where the strawberries would be able to grow without frost-induced risks, and other extreme weather conditions.

Specifically, the project aims to address the following:

1. Construct a vertical indoor farm capable of sustaining a controlled environment as an effective alternative in cultivating and growing of strawberries.
2. Monitor, simulate, and collect data regarding the growth of Strawberries in a vertical indoor farm
3. Use the data gathered for determining the effectivity of the implementation of a vertical indoor farm.

Proposed Method:

1. Scientific and technological

The researchers proposes to conduct a study of creating a controlled agricultural environment (indoor farming) that will be used for growing strawberries (*Fragaria x ananasa*). In today's age, Heating, Ventilation, Air-Conditioning, and Refrigeration technologies play a significant role on indoor farming as it allows for climate control where the worsening climate conditions makes farmers switch to indoor farming.

As shown on fig. 1, the researchers proposed the use of HVAC-R equipment such as humidifiers, dehumidifiers, ductless air rotation systems, direct-fired heating, evaporative cooling, etc., as these equipment are essential to successful climate control and effective indoor farming system.

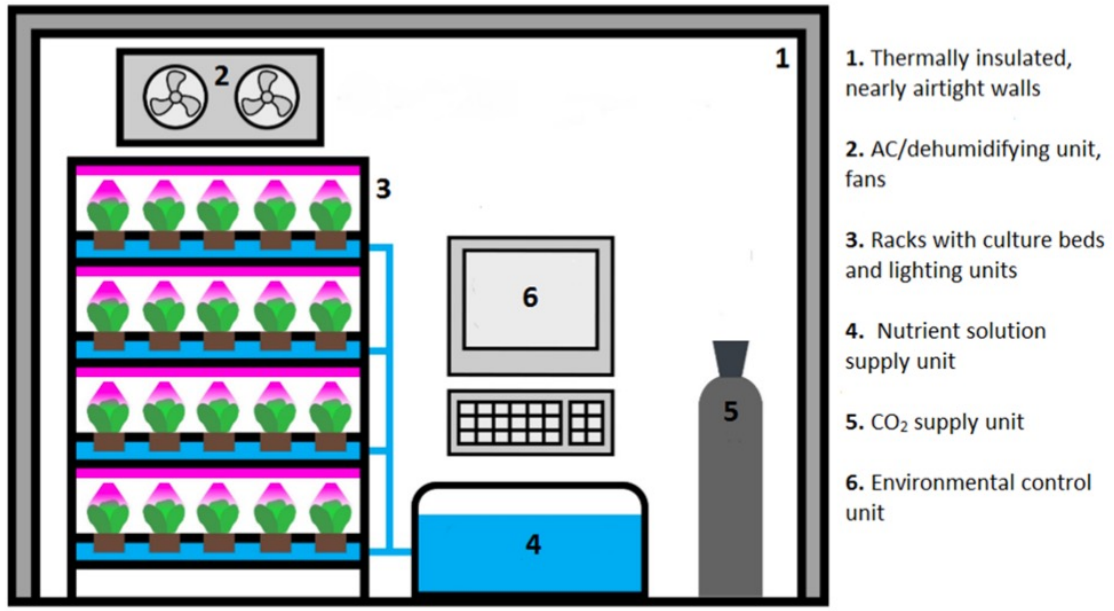


Fig. 1: Main Elements of a Typical Vertical Indoor Farm
(Van Gerrewey, T.; Boon, N.; Geelen, D. Vertical Farming: The Only Way Is Up? Agronomy 2021, 12, 2)

Proposed Method:

2. Implementation

Phase 1, conceptualization and research regarding on the HVAC-R equipment that will be used in the vertical indoor farming system. The proposed vertical indoor farm is projected to be used in planting and harvesting strawberries in certain regions of the Philippines where strawberries aren't normally grown. The vertical indoor farm will replicate the climate conditions in Benguet where strawberries are locally grown and harvested.

Phase 2 which is the fabrication and optimization of different parts that make up the vertical indoor system. This includes the dehumidifier, humidifier, ductless air rotation systems, direct-fired heating, evaporative cooling, etc.

Phase 3 These equipment will then undergo testing and simulations by the researchers to determine the efficiency of the controlled environment setting.

Phase 4 the study itself can be continued by future researchers as the reach and potential of the indoor farming industry is broad and promising

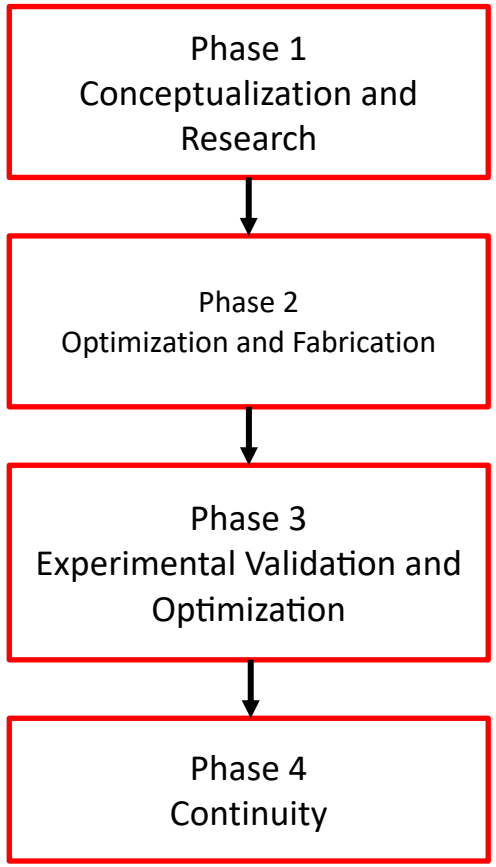


Fig. 2: Conceptual Framework

Proposed Method:

3. Experiments including field testing

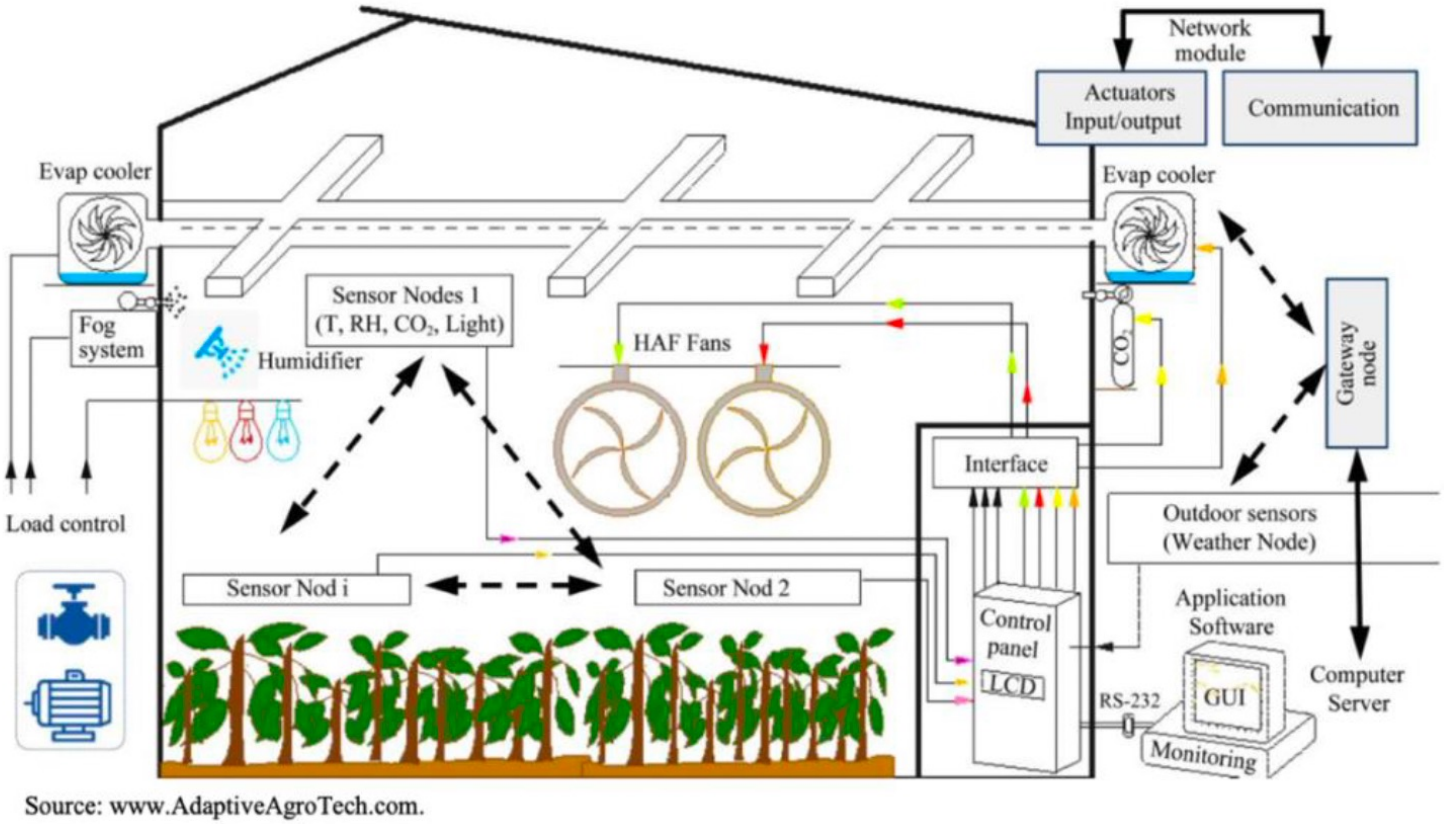


Fig. 3: Sample of a Greenhouse Environmental System and Components (Source: www.AdaptiveAgroTech.com)

- Container Van / Room
- Temperature, Humidity and Light Intensity, Water and CO_2
- Use of HVAC-R equipment such as humidifiers, dehumidifiers, ductless air rotation systems, direct-fired heating, evaporative cooling
- Application Software for monitoring the environmental parameters inside the room
- Strawberries

Impact:

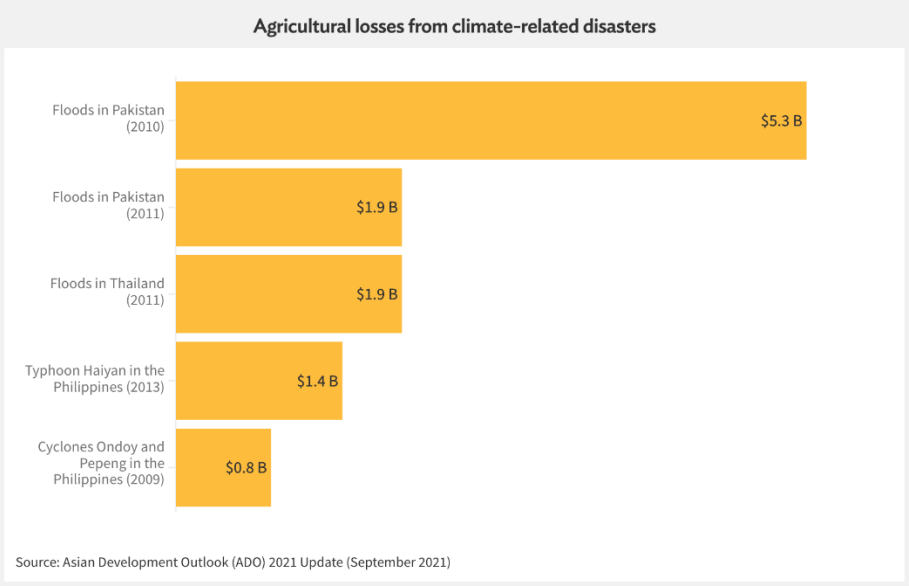
- Controlled Environment Agriculture (CEA) empowers more people to grow practically any fruit or vegetable in a small area and with minimal resources.
- Some facilities might be constructed for community agriculture, which allows local residents to contribute to the growing of the crops without incurring additional costs.
- Urban agriculture generally has been found to help decrease food shortages and provide access to healthy foods.

Output/Outcome:

The target output of this study shall be to construct vertical indoor farming through the proposed method of utilizing **HVAC-R equipment** in a container van that can sustain a controlled environment to cultivate and grow strawberries (Fragaria x ananassa) effectively. This proposed method shall produce the following outcomes:

- **Agricultural Sector** – The model of the constructed vertical indoor farming shall be made available to the public, specifically targeting the agricultural sector, as the proposed method is set to be an alternative to the conventional form of farming and potentially increase the crop's level of production.

  - **Food Security** – The proposed model of vertical indoor farming also targets to decrease, if not eliminate, the impact of weather-climate-related constraints such as climate-related disasters.



- **Future Researchers** – The study will also monitor, simulate, and collect data regarding the growth of strawberries in a vertical indoor farm that shall be made available to future researchers with the same interests and motivations in vertical indoor farming to further expand the current study for future innovations

Conclusion:

- The effects of climate change pose negative impacts on various sectors and one of those is agriculture. With the continuous advancement in technology, this concern has contributed to the creation of Controlled Environment Agriculture (CEA). This concept pertains to circumstances where crops are shielded from the extreme environmental conditions and have the capacity to manage, oversee, and regulate the microclimate of the cultivation area.

- With more farmers turning to the indoor farming technology industry due to worsening climatic conditions, HVAC-R plays a critical role in controlling and maintaining these artificial farming environments. In line with this, HVAC-R equipment such as humidifiers, dehumidifiers, ductless air rotation systems, direct-fired heating, evaporative cooling, etc., are essential to successful climate control.

- The researchers aim to construct an HVAC-R set-up, vertical indoor farm capable of sustaining a controlled environment replicating the appropriate conditions for effective farming in cultivating and growing of strawberries (Fragaria x ananassa) in places outside the ideal location where they are normally grown. Specifically, the study will monitor, simulate, and collect data regarding the growth of Strawberries in a vertical indoor farm and use the data gathered for determining the effectivity of the implementation of a vertical indoor farm

- This will significantly contribute to the agricultural sector in the Philippines by introducing them to an alternative method of farming which could also potentially increase their level of production. Additionally, researchers with the same interests and motivations in vertical indoor farming could use this research as a guide and inspiration for future innovations.

Project Title: Controlled Environment Agriculture for the Effective Growth of Plants in Indoor Farming

Thank you very much for listening

- If you are interested in this project and want to do collaborative research ….
    - jfvillaverde@mapua.edu.ph