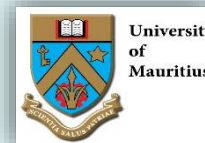




Protected cultivation: an alternative for farmers to adapt to effects of climate change

*Navindra Boodia
Senior Lecturer
Faculty of Agriculture
University of Mauritius*



Roadmap

✓ **Background**

- Definition
- Types of Structures
- The Current Context
- Objectives



✓ **Siting and design considerations**

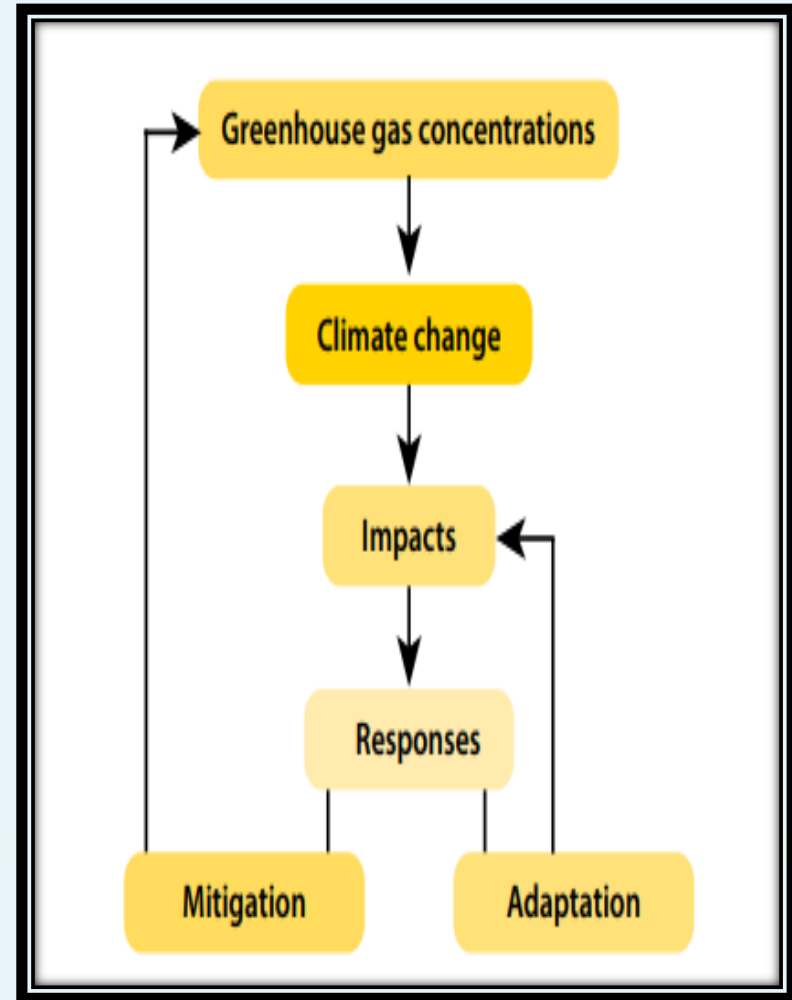
✓ **Adaptation to CC effects**

✓ **Sheltered farming: In the context of CSA**

✓ **Take-home lessons**

Let's get the definitions right!

- ❖ Both mitigation and adaptation are strategies to address CC
- ❖ **Mitigation:** intervention to reduce emission sources or enhance the sinks of GH gases.
- ❖ **Adaptation:** Adjustment made to the system, in response to the CC effects, in order to lessen the harm (IPCC, 2001)



Protected Cultivation: Definition

- ❖ Protected Cultivation: cropping technique wherein the micro climate surrounding the plant canopy is controlled partially or fully as per the requirement of the crop species.
- ❖ Viable technology to attain self-sufficiency.
- ❖ Adaptation option to address climate change.
- ❖ However, many growers have not been able to sustain or optimize crop yields due to:
 - inappropriate designs of protected structures, particularly for the climate in the region
 - 'high' costs of the structures

The Shift



**Open field
Agriculture**



**Sheltered
Farming**

Assumption: It is not necessary to include a hydroponics system to cultivate crops.

Types of Protected Structures

Mini cloches	Quonset plastic house
Mini tunnels	Plastic greenhouse
Low tunnels	Polycarbonate greenhouse
High tunnels	Multi-span/ ridge and furrow greenhouse
Shade house	Glasshouse (Venlo; sawtooth etc...)
Insect-proof net house	Climatic chambers

What's the difference?

- Level of climate control that they confer
- Degree of sophistication
- And of course: costs!



Budgetary Measures 2017-18-19

❖ Purpose of the Scheme

- Encouraging farmers to shift from traditional open field cultivation to sheltered farming system.
- Enabled environment to adapt to the effects of adverse climate.

❖ Details of the Scheme

- A grant of 50% on investment costs up to a maximum of Rs 250,000.

❖ Implementing Agency

Food and Agricultural Research and Extension Institute (FAREI)



Compatibility with Sustainable Agricultural Systems

- SMART Agriculture
- MauriGAP standards
- Climate Smart Agriculture Approach
- Bio-farming
- Songhai model of integrated farming
- Aquaponics and vertical farming



Advantages of SF

- Protection against winds
- Minimize the impact of heavy rain
- Prevent soil erosion
- Reduce leachates to the soil environment
- Reduced usage of crop protection chemicals
- Higher crop yields
- Better crop quality; reduced pesticide residues etc.....
- Shelter for beneficial insects (natural enemies)
- Earlier production

In this presentation...

We will examine:

- ✓ why proper planning, design and layout are needed to succeed with protected cultivation/ sheltered farming (SF)
- ✓ how structures/ accessories can be modified to adapt to climate change
- ✓ SF, in the context of CSA



PART I. SITING & DESIGN CONSIDERATIONS

SITING & DESIGN CONSIDERATIONS

Constraints to Farming (Tropics)

- Intense heavy rainfall (flash flood), storm, strong winds, insect pests, high daytime temperature, high RH, droughts etc...

Therefore, there is need for special requirements for tropical SF. Most of these have to do with the site selection and design features: covering materials, GH orientation & structural materials and set-up.

Site Selection

- Avoid marshy land and flood-prone areas.
- Choose regions with established drainage systems.
- Choose land that slopes down to nearby canals
- Look for a natural wind-break
- Avoid shading trees etc...

GH Orientation

- How to orient the ridge of the GH?
- North-South orientation: rows of crops to be aligned N-S
- Reasons:
 - Maximum natural ventilation via the side vents
 - Minimal mutual shading among plants

<https://www.dpi.nsw.gov.au/agriculture/horticulture/greenhouse/structures-and-technology/siting>

Structural design

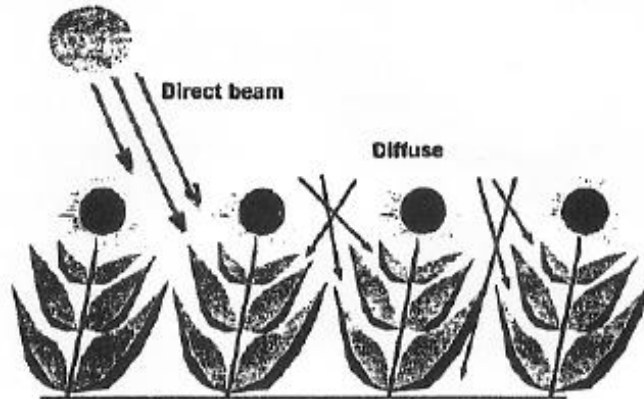
Sufficient stability of the construction to wind and crop loads



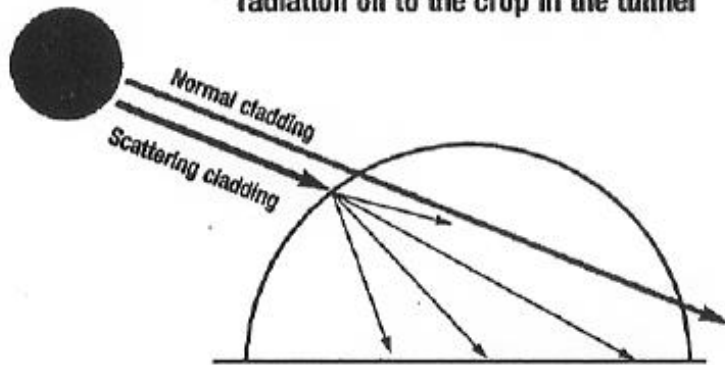


II. ADAPTATION TO CC EFFECTS

SMART Cladding Materials



[2] How diffusing cladding 'scatters' some of the solar radiation on to the crop in the tunnel



E.g. Luminance THB
(developed by the
University of Reading)

Optimizing light utilization
within the sheltered farm

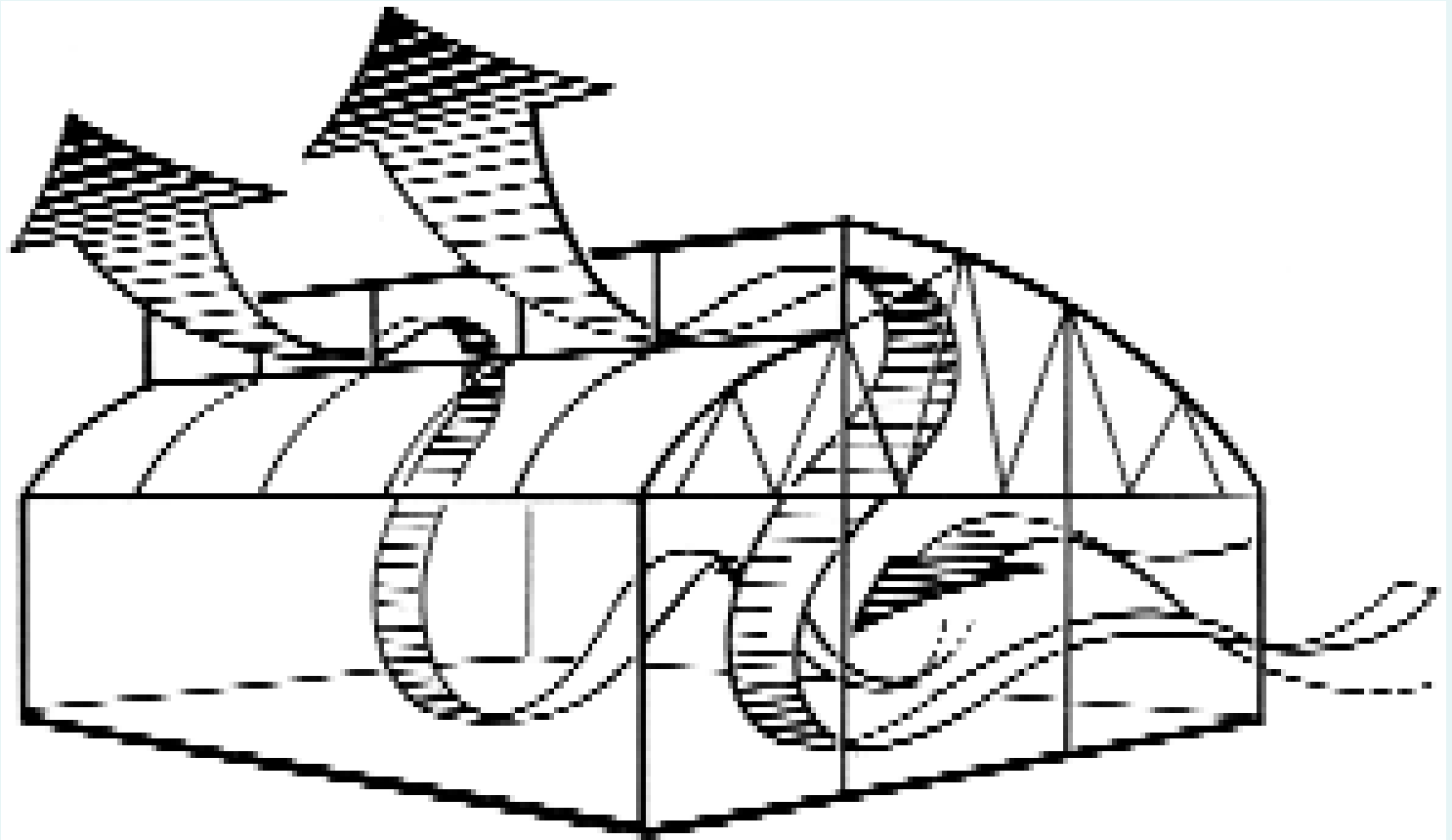
Dealing with High Temperature (I)

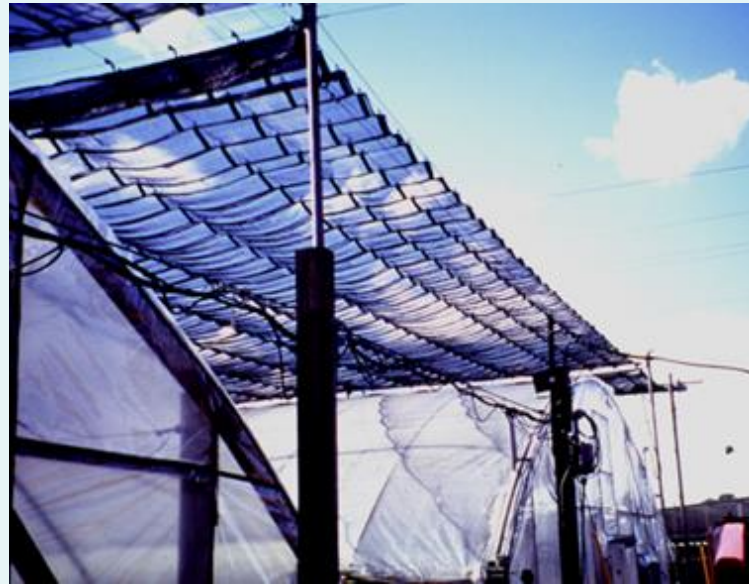
- Modification to protected structures
 - Reflective shade cloth
 - Shading compounds
 - Thermal curtains
- Use structures with ridge vents



Ridge vent

Warm air escapes through the ridge vent





Dealing with High Temperature (II)

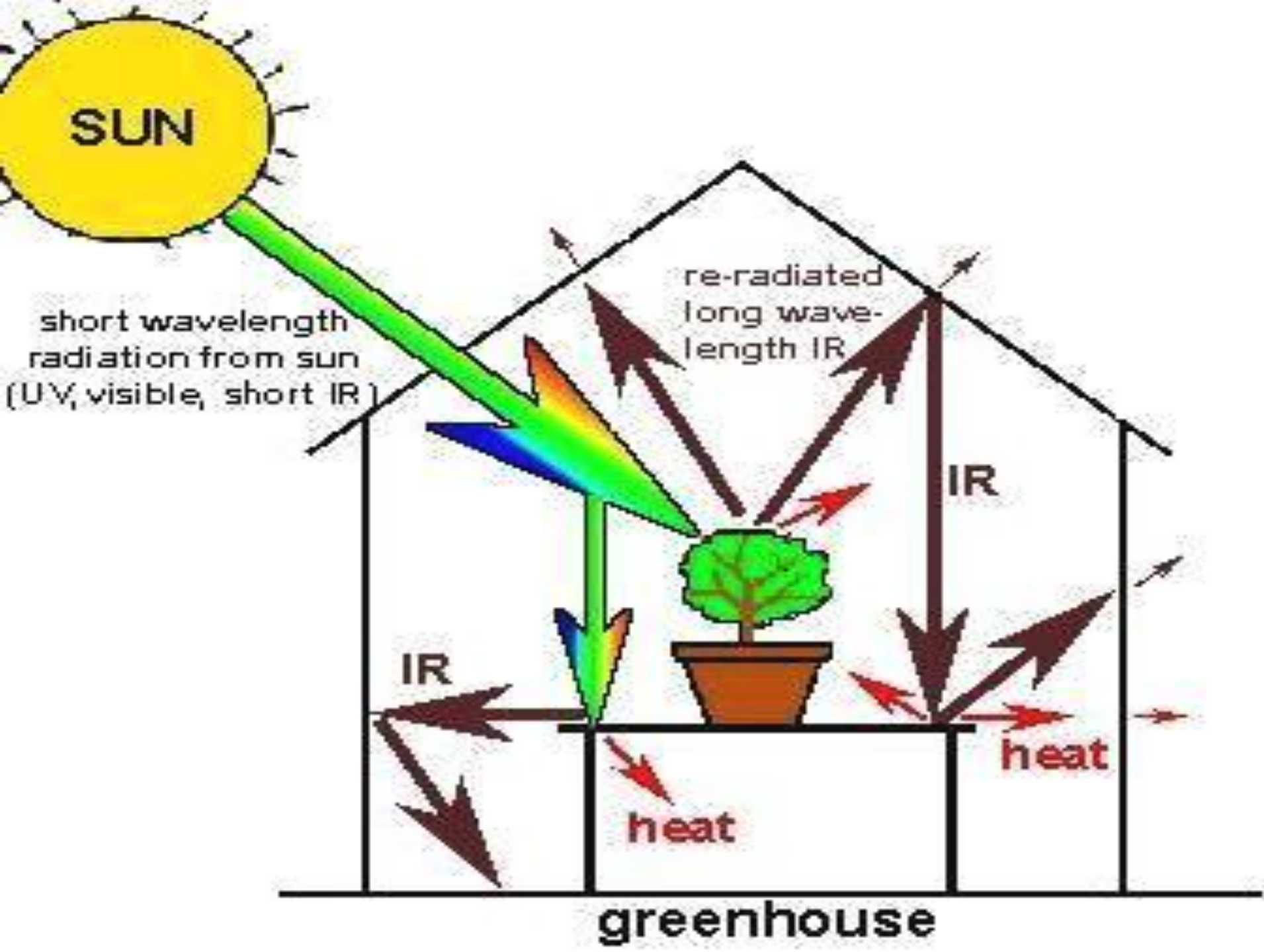
- Smart plastic films
 - Block IR light and prevent heating
 - Transparent to long-waved IR light (allow this to escape), such that the SF doesn't heat up

Solar Radiation

- UV light: below 380 nm
- PAR: Photosynthetically active radiation (400 – 700 nm)
- NIR: Near Infrared (short-waved IR), heat from sun (700 – 3 000 nm)

Emitted radiation from heated objects

- FIR: Far Infrared (long-waved IR), heat from soil and other bodies (3 000 – 100 000 nm)





Dealing with High RH (I)

- High RH can accumulate within SF
- Implication: water condensation on ceiling
- Consequences:
 - Water droplets falling on plants
 - Reduction in light transmission into SF
- Options:
 - Proper orientation of SF (maximum air exchanges)
 - Highly efficient ventilation systems, using horizontal airflows
 - Water-saving irrigation system, favouring high water use efficiency

Dealing with High RH (II)

Researchable Options

- Adding special additives to the GH film such that water droplets are not formed but rather a thin transparent water film is formed.
- Determine the critical roof inclination angle of different films to avoid condensates dripping down onto the plants.



III. SHELTERED FARMING (SF): IN THE CONTEXT OF CSA

SF: In the context of CSA...

A means to implement biological control

BC is used regularly on an estimated area of 15 000 ha (mostly on vegetables) - Parella *et al.*, (1999)



Aphids (*Aphis* spp) with mummies parasitized by a parasitoid Wasp (*Aphidius colmani*)

Biological control can be defined as the action of natural enemies, which maintains a pest population density at a level lower than would occur in the absence of these enemies

Parasitoid



Predators



SF: In the context of CSA...



Water harvesting: wash floors and other structures of the GH

SF: In the context of CSA...

Aids in the process of adopting organic farming

SUCCESS
Story?

Songhai Model in Benin.

<https://www.youtube.com/watch?v=r-YbCN9H8Ng>

Nutrient-rich treated and bio-filtered waste water from aquaculture farms is used to fertilize the crops.

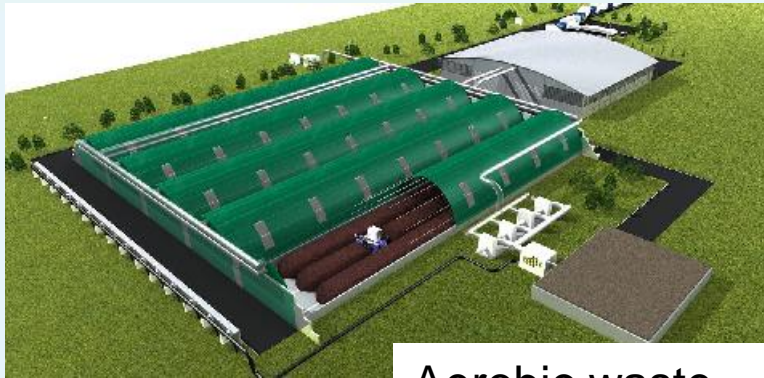
Songhai Model (Contd.)

- Plastic mulching is used to conserve water, prevent weed growth and provide a soil environment that promote growth of beneficial microorganisms like *Nitrobacter* and *Nitrosomonnas* spp...
- Be careful, not any type of plastic mulch! But, a SMART film: UV treated; IR blocking/ reflective...



SF: In the context of CSA...

Sequestration of flue GH gases from industries and composting plants



Aerobic waste treatment for composting



CO₂ capture technology



CO₂ enrichment (CDE) via inflated plastic lubes

Crops respond very well to CDE (800-1000ppm): higher yield and better quality



Sheltered farming



YES!



Take-home Lessons!

- SF: viable technology to adapt to CC.
- Compatible with current sustainable agricultural systems.
- Siting, planning, design and proper layout are keys to success.
- Need to adapt the technology to our soils and climate: modifications are crucial!
- A low-input affordable semi-protected structure is available to farmers

ACKNOWLEDGEMENTS

- University of Mauritius
- Dean of Faculty
- Departmental Head (APS)
- Organizers and Organizing Committee of this training Course
- Funders &
- CCARDESA

