“Urban Rooftop Hydroponics for Diversified Agriculture: A Strategy for Sustainable Global Cities in Emerging Economies”

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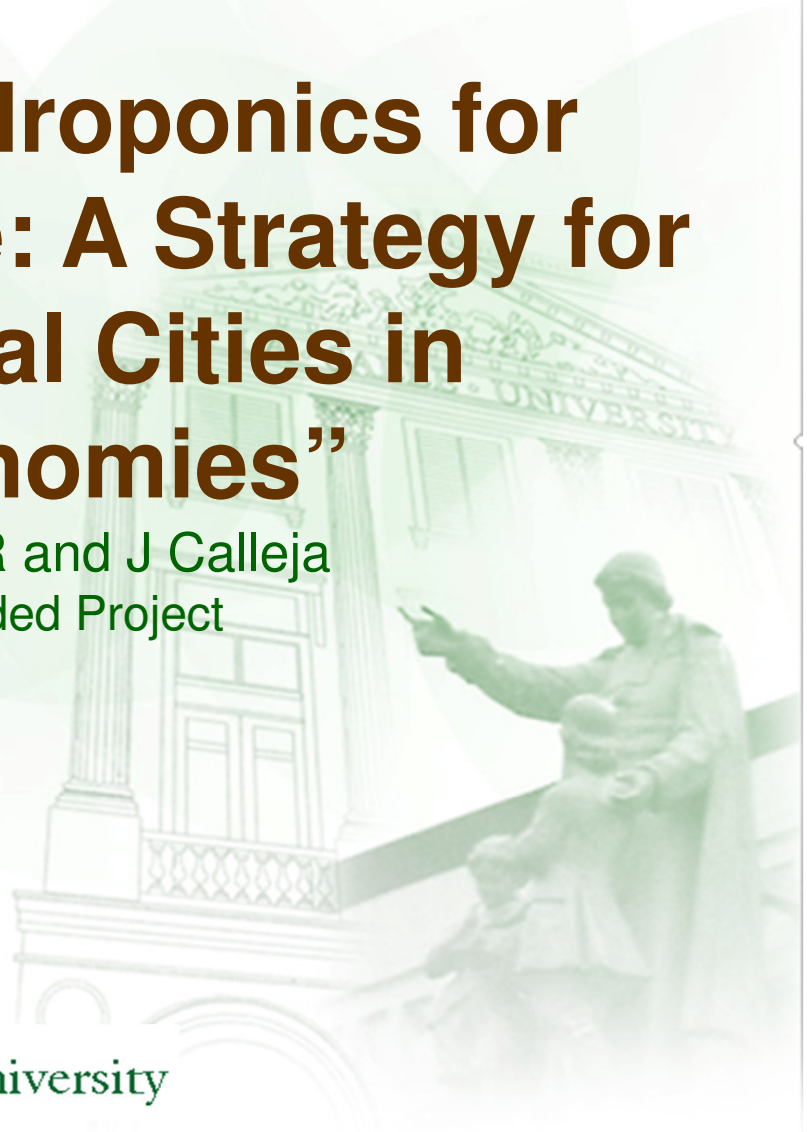
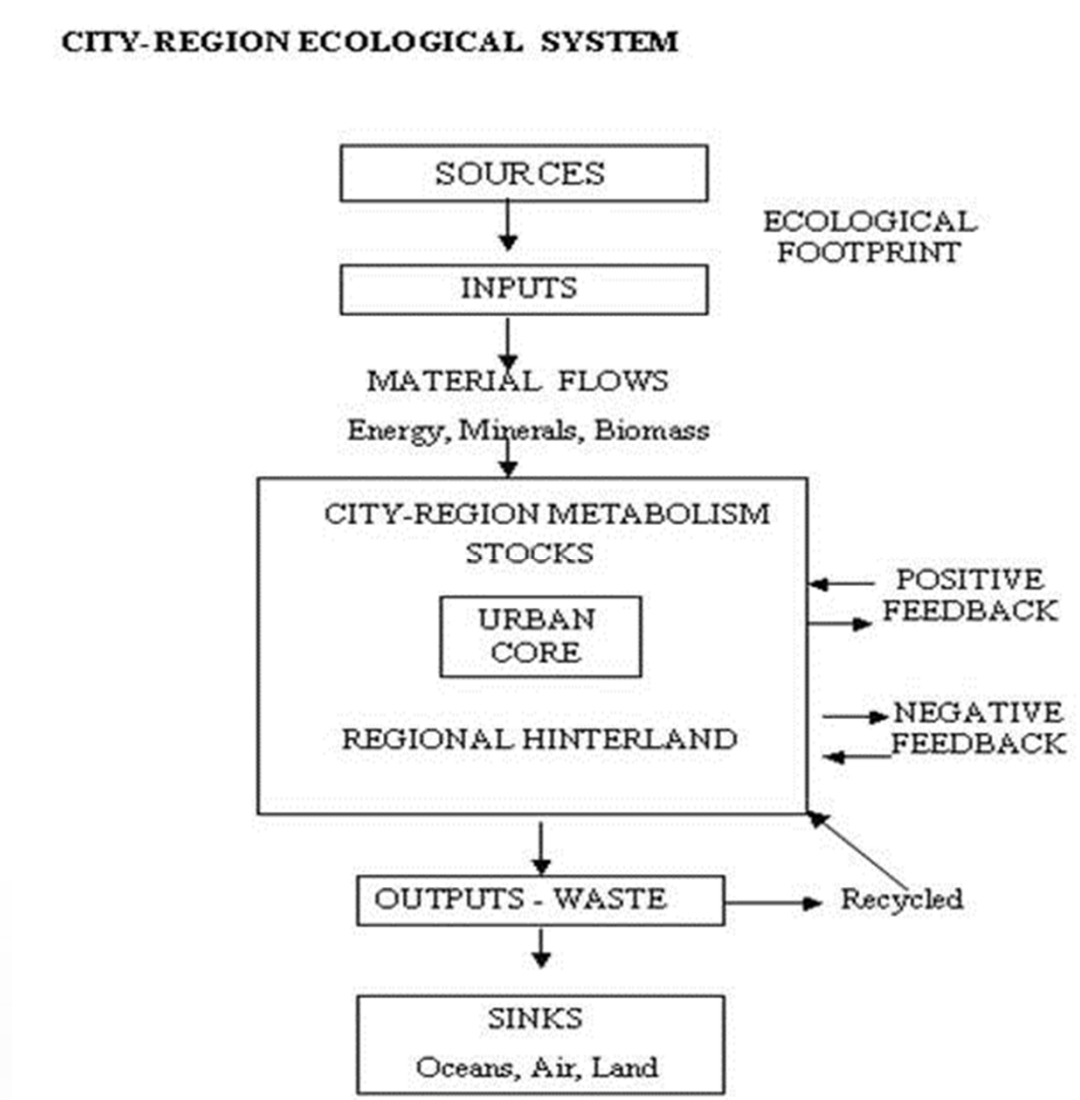
Angelo King Institute Funded Project



De La Salle University

Conceptual Framework



Urban Metabolism Model (Taylor, 2012)

Research Questions

- 1. What is the best design for an urban rooftop hydroponics installation?
- 2. What quantities of water and nutrients are optimal for growing lettuce in urban rooftop hydroponics?
- 3. What are the costs of urban hydroponics lettuce production based on the model of on-site production and on-site consumption and compare this price to the price of lettuce purchased on-site for the local canteens?
- 4. How much carbon reduction can occur by growing lettuce and micro greens on building roofs in Metro Manila? And, how much roof space would be needed to meet the demands for lettuce supply in Metro Manila?

Further Research Questions

This project will not answer the following questions quantitatively but will provide enough information to make intelligent decisions or policy.

1. The project provides basic information so that a scaled up project can be undertaken utilizing the cost ratios of the pilot project extrapolated to larger or more commercialized rooftop installations.

2. This project will produce as a next step the gathering of information on the amount of unused rooftops that can be used for hydroponics using either a traditional building survey or a more technologically advanced LIDAR evaluation.

3. The development of a business model that connects on-site rooftop hydroponics with on-site canteens or restaurants.

Expected Tangible Outcomes

1. A determination of the costs of production of rooftop lettuce in pesos per output.

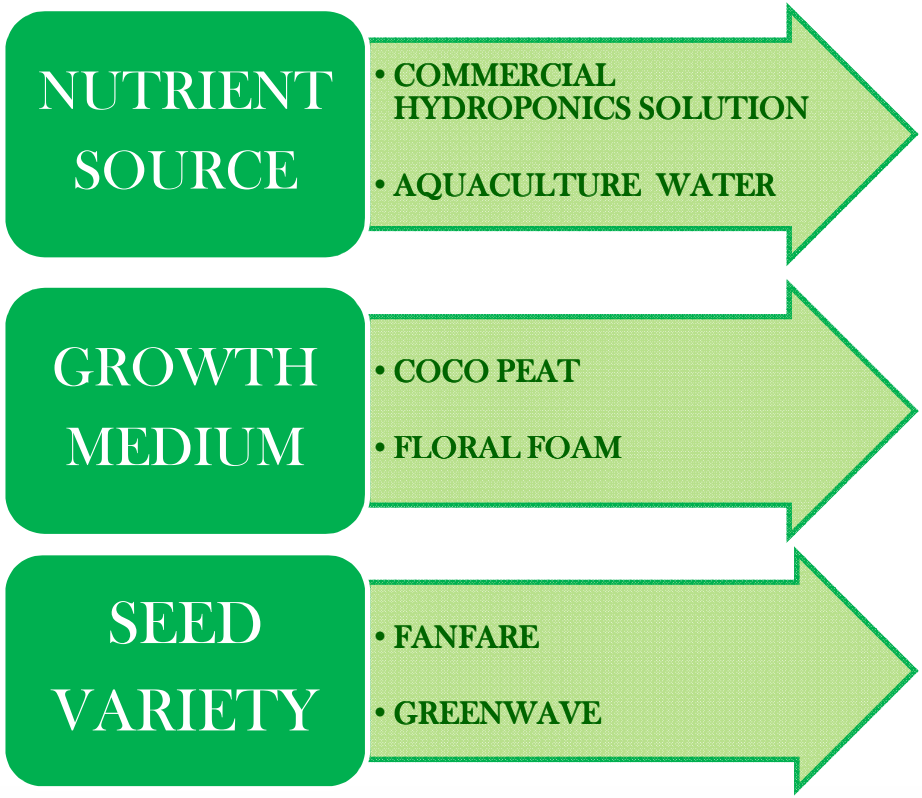
2. A determination of the costs of on-site production is greater or lesser than traditional supply chain costs.

3. A determination of the most effective "sun positioning system" for growing rooftop lettuce.

4.The determination of the amount of water and nutrients that are used per lettuce output in rooftop hydroponics measured against the traditional lettuce supply chain product.

5.The determination of the amount of carbon not released by lettuce supply to Metro Manila through the substitution of rooftop hydroponics for traditional imported lettuce.

Experimental Design



YIELD

PER CENT GERMI-NATION	GROWTH PERIOD	HARVEST WEIGHT

SEED PREPARATION

THE EXPERIMENTAL SET UP

AT 2.5 WEEKS AFTER TRANSPLANTATION

The Benchmark

PhP 30 OR USD 0.70 PER POT

http://www.sulit.com.ph/index.php/view+classifieds/id/1276551/Lettuce+for+Sale,+Fresh+Live+,+Lettuce

Results

Best design for an urban rooftop hydroponics installation.	
Challenges	**Stragetegies Used**
Lightweight. Should be within the weight bearing capacity of the building.	Steel tube framing structure.
Protective against intense light, strong wind, heavy rains and predators and parasites.	Covered with layers of nylon nets with fine mesh.
Conserves water.	Closed hydroponics set up (PVC pipes).
Conserves energy.	Solar powered pumps and aerators.
Do not need to be transported from faraway places.	Use open areas in campus e.g. Rooftops.
Minimal waste production.	Used nutrient solution is still good for watering other vegetation in campus. Used germination material is composted or used in vermiculture.

Results

Water Footprint of Lettuce (liters of H_2O per kilogram lettuce produced)	
Global estimate (Waterfootprint.org , 2008)	130
Green wave variety (our study)	56
Fanfare variety (our study)	28

Results

Reduction of CO_2 in Lettuce Supply to Metro Manila	
SOURCE	CO_2 SAVINGS in Tons
Food Miles from Air Freight	1,544.95
Food Miles from Truck Freight	283.18
Energy Building Efficiency of Green Roofs	134.54
Total CO_2 Reduction in Lettuce Hydroponics	1,962.67

Results

Market Price of Lettuce (PhP)	
Iceberg variety (BAR, 2005)	75-280/kg
RFM Hydroponics (2011 posted at Sulit.com)	30/pot
Our study	30/pot

Conclusion

Urban agriculture is not only feasible but also:

1. can be profitable and thus help address the problem of food security;
2. addresses the problem of water security; and
3. addresses climate change issues.

Every Step Counts

"That's *one small step for* [a] *man*, one *giant* leap for *mankind*..."

Neil Armstrong

Thank you for listening!

Lactuca sativa

Lettuce mix.jpg

Iceberg lettuce in SB.jpg

- Kingdom: Plantae (unranked): Angiosperms (unranked): Eudicots (unranked): Asterids Order: Asterales Family: Asteraceae Genus: *Lactuca* Species: ***L. sativa***

Notes

- [1] There are assumptions made in these calculations that were derived from reasoning and not from extensive survey research. While it is recognized that rooftop hydroponics will reduce the carbon footprint of Metro Manila, the exact amount presented by the researcher is only a best estimate.
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- [2] These figures constitute best estimates that were determined through Interview by Robert W. Taylor of Ronald Canja, Distribution Manager for Metro Manila, Dizon Farms, May 30, 2012.
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- [3] CO2 from Air Freight was determined at 3.15 grams of CO2 per gram of aviation fuel (www.carbonindependent.org). Although aviation fuel has 1.9 times more global warming capacity than CO2 since it contains nitrous oxides and water vapour, this was not factored into the final estimate of CO2.
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- [4] Calculations were based on 3.2kg of CO2 produced per liter of diesel fuel. This figure was supplied by Herman Nandapawar, International CDM Specialist, Energy Climate Change Expert, Asian Development Bank to Robert W. Taylor on June 6, 2012.
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- [5] This estimate is based on the work of Cynthia Rosenzweig in "(Soil) Carbon Sequestration in the Urban Environment," World Bank, May 13, 2009. She calculated that for every 100 sq. ft. (96 sq. meters) of green roof in New York City 138.19 lbs. (62.682 kg.) could be saved during the three summer months. Since her calculations were derived from soil-based green roofs and not from vegetation produced through hydroponics, and that Metro Manila has 12 months of building cooling needs rather than just 3 months, only 25% of her carbon savings per 1000 sq. ft. of roof were used. Also, although no exact estimate of carbon savings was provided, Changi General Hospital in Singapore placed hydroponics on their roof and noticed that "the hydroponics plants planted on the roof help absorb heat, making naturally ventilated wards cooler." Accessed through www.greenroofs/pview.php?id=565 by Robert Taylor, June 20, 2012.
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- [6] This estimate is based on a hydroponic greenhouse, Gotham Greens, in Brooklyn, New York City that projected 100 tons of lettuce and micro greens per 15,000 sq. meters.