RUTGERS
School of Environmental and Biological Sciences

Hydroponics at Rutgers' School of Environmental and Biological Sciences, New Brunswick, NJ

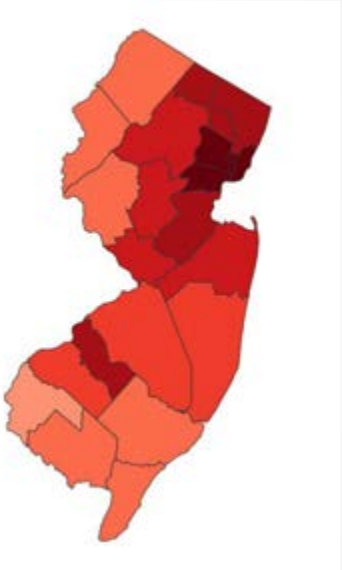
Albert Ayeni, Ph.D.
Plant Biology Department
Rutgers SEBS
59 Dudley Road, New Brunswick, NJ 08901
aayeni@sebs.rutgers.edu
848-932-6289

Presentation at the Urban Ag Workshop, Rutgers SEBS, New Brunswick, NJ , December 14, 2018

Background

Why Hydroponics at Rutgers University?

- New Jersey has the highest population density (average1195 people/m^2) in the United States; the only state in the Union with every county considered urban ($\geq$400 people/m^2 US Census Bureau 2010)
- Available land area for field crop production is limited
- Communities are becoming more interested in locally produced food for good nutrition, biosafety and health reasons



Why Hydroponics at Rutgers University?

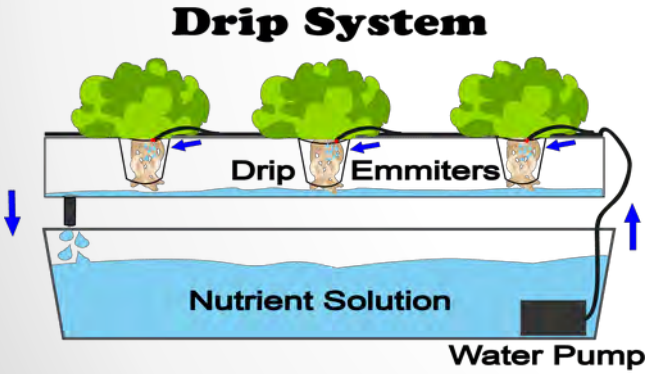
- We must develop other more space-efficient agricultural technologies to produce locally to meet the needs of our communities
- Rutgers University's SEBS/NJAES with Land Grant responsibilities has a unique opportunity to research and develop novel growing systems that will ensure the necessary supply of fresh and locally grown produce throughout the state

Why Hydroponics at Rutgers University?

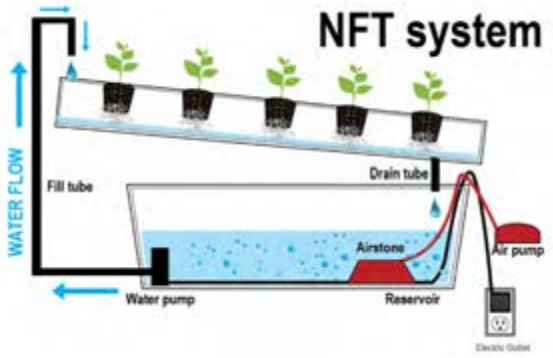
- Hydroponic and aeroponic crop production systems offer promising and exciting opportunities and can increase the number of high paying job opportunities that are necessary to attract the next generation of farmers
- These crop production systems also offer excellent teaching, research and outreach opportunities

What is Hydroponics/Aeroponics/Geoponics?

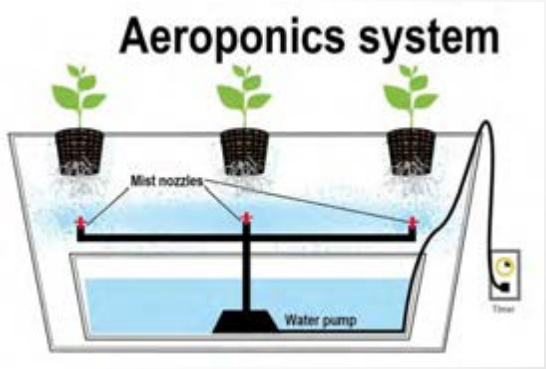
- Hydroponics refers to growing plants in a soilless medium, usually done in a controlled environment.
- The plant root system derives the essential nutrients directly from water solution in liquid (hydroponic) or vapor (aeroponic) form.
- **Geoponic** is the culture of plants in a "soil" medium, usually in a controlled environment.



Source: http://www.nosoilsolutions.com/drip-hydroponics/



Source: http://greenbookpages.com/blog/285353/which-hydroponic-system-is-right-for-your-grow/



Source: https://www.quora.com/How-does-aeroponic-vertical-farming-function

Hydroponics at Rutgers' SEBS

- Started in November 2016 as part of a bigger initiative called the Indoor Cultivation initiative or Controlled Environment Agriculture (CEA)

- Mission: To provide experiential learning opportunities for SEBS students involving several indoor cultivation systems, including the geoponic and hydroponic (soilless) plant production systems. The initiative also provides an opportunity to showcase indoor plant production systems to a wider audience. Research collaborations with SEBS and other researchers are also promoted through this initiative.

Indoor Cultivation Organization

Leaders:

- Albert Ayeni Ph.D. (Plant Biology)
- A.J. Both, Ph.D. (Bioresource Engineering)
- William Sciarappa, Ph.D. (Cooperative Extension)

The Leaders


Albert Ayeni


A.J. Both


Bill Sciarappa

Assistants:

- Dennis McNamara (since 2016)
- Jonathan Dmitruck (2016-2018)
- Adam Lotfi (since 2018)
- Brooke Prusa (since 2018)

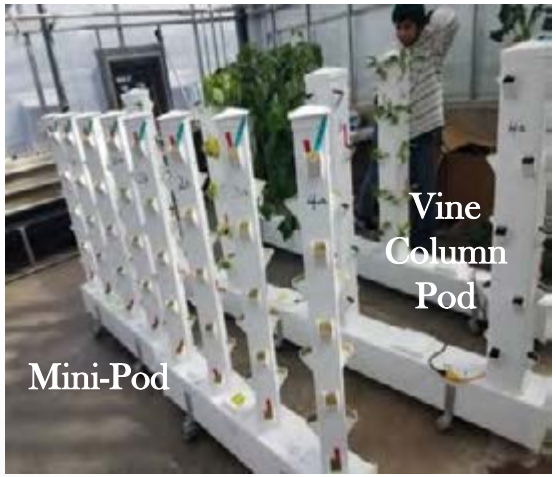
Supporters:

- Rutgers' SEBS Administration
- Plant Biology Department
- Department of Environmental Sciences
- Department of Agriculture and Resource Management Agents

Collaborators:

- Rutgers Dining Services
- AERO Development Corp, LLC

Rutgers Indoor Cultivation Systems



PRODUCTION

Geoponic Production: Pots filled with greenhouse mix and ready for seeding

Geoponically Grown
Rutgers Scarlet Lettuce
(RSL)

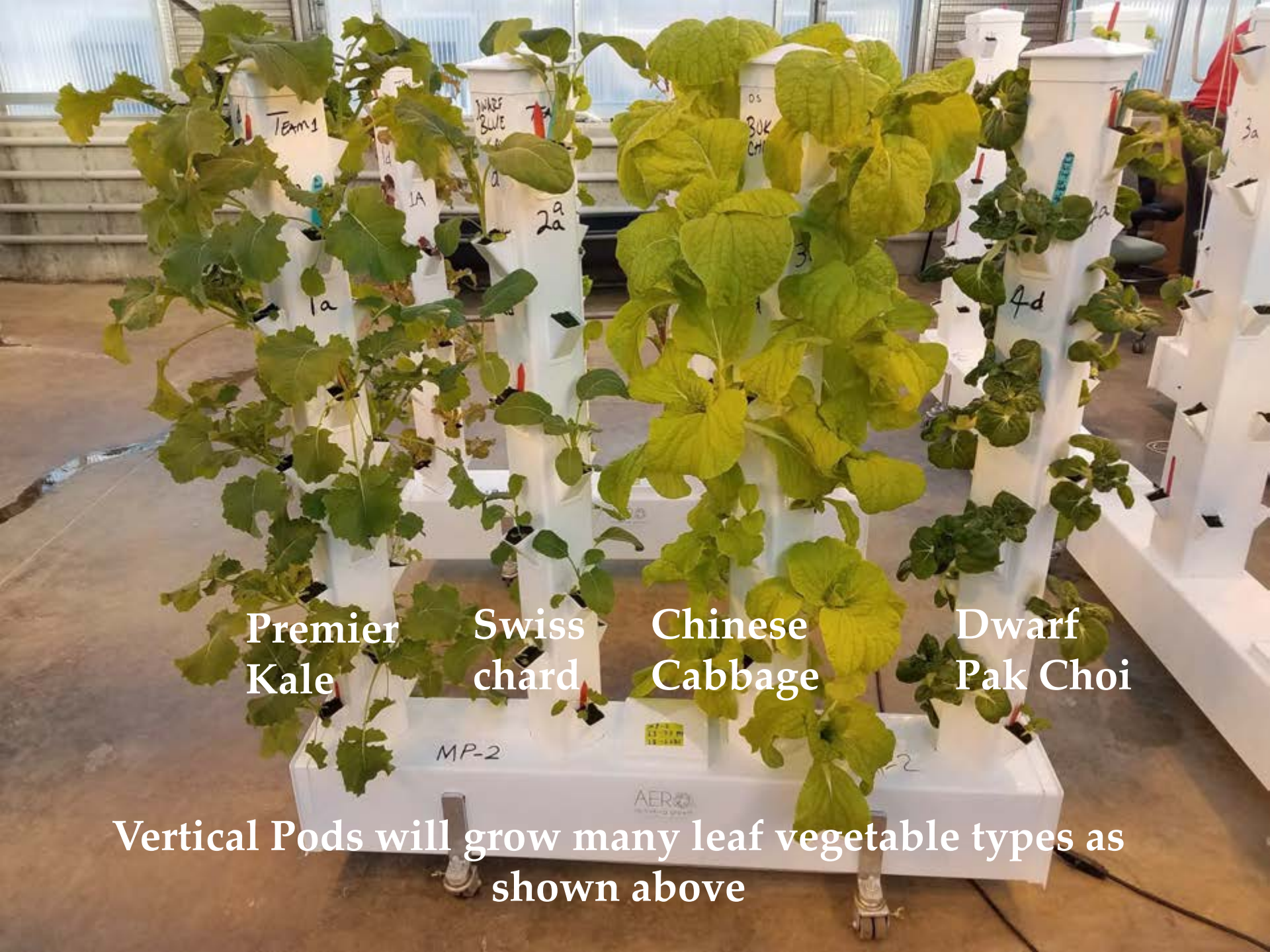
Geoponically Grown
Asian Amaranths

Hydroponic Culture

- Seedlings may be raised in rock wool in the nursery for two weeks, then transferred to the vertical columns or horizontal troughs for three to four weeks and then harvested (for leaf veggies). Where seed viability is known to be high, direct seeding on the hydroponic structure may also be done to save the nursery phase of production.

Seedlings in rock wool at emergence

Seedlings at 2 weeks after seeding, ready for transfer to the hydroponic structure



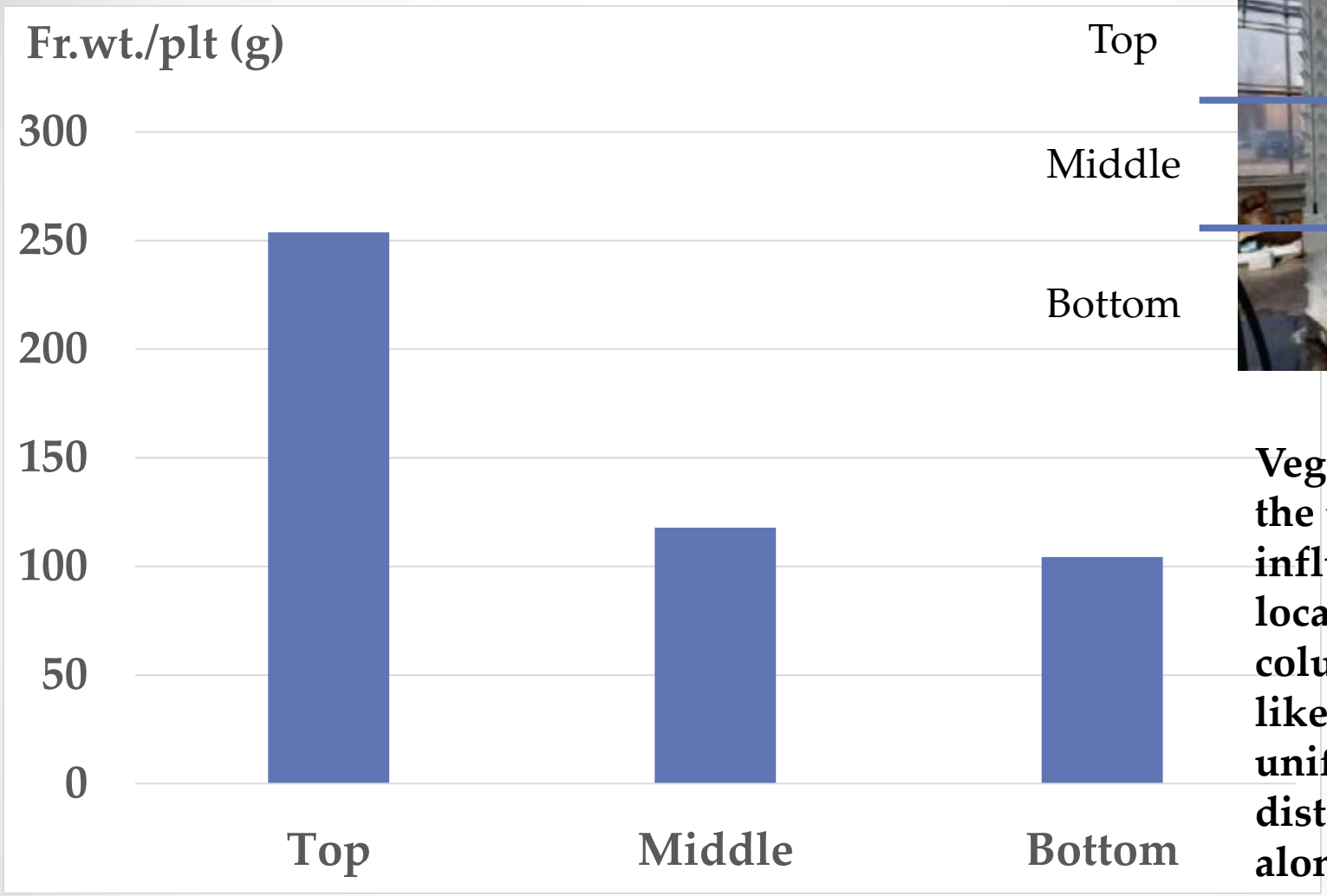
Vertical Pods will grow many leaf vegetable types as shown above


RSL
Bibb Lettuce
Red and White Swiss Chard


Chinese Cabbage
Premier Kale
Ready for harvest
2a
2b


Eggplant
Bell pepper
The Vine column pod supports fruit Veggies


Octagonal Vertical Pod supports a
wide variety of leaf veggies



Veggie growth on the tall tower is influenced by location on the column --- most likely due to non-uniform light distribution along the column

Bibb Lettuce Growth on the Octagonal Vertical POD


The Nutrient Film Technique
RSL at three weeks after seeding


The Nutrient Film Technique
RSL six weeks after seeding

The Nutrient Film Platform may be used to produce a variety of leaf veggies side by side simultaneously

HARVESTING


Harvesting Time ---
Vertical Column


Harvesting Time from
NFT

Packaging

RSL from NFT

RSL from the tall tower

Boxed Hydroponic Veggies --- ready for delivery

Hydroponic Management Issues

Water/Nutrient Management

Hydroponic veggies are highly sensitive to moisture stress. In this photo premier kale is showing water stress symptom as the water in the pod tank was depleted over a weekend when no one was around to refill the tank. As the water solution is the medium for nutrient supplies, anytime there is water stress the plant also suffers some nutrient stress.

Aphids, thrips, white flies, etc. could also be a problem in hydroponic veggie culture

For the cool season veggies bolting is a common problem under high temperature and long day length. In this photo, pak choi is bolting aggressively and flowering. Not good for leaf production

Hydroponic vs. Geoponic: Some Quick Facts

Hydroponics vs. Geoponics

Attribute	Geoponics	Hydroponics
Growth medium	Soil based	Soilless
Nutrient supply	Slow release	Available instantly
Technology Integration	Low technology input	High technology input
Crop hygiene	Crop less clean	Crop more clean
Management and maintenance attention	Reduced management/maintenance attention	High management/maintenance attention
Plant growth rate	Most vegetables grow more slowly	Most vegetables grow faster and bigger
Water use efficiency	Less efficient	More efficient*

**Water use efficiency is considered a major comparative advantage of hydroponics over geoponics. Water is recycled in hydroponics and lost only through plant transpiration, compared to the geoponic system where there are multiple channels for water loss including evaporation from the soil surface and drainage --- which increases pollution problems.*

Hydroponics vs. Geoponics

Attribute	Geoponic	Hydroponic
Energy use	Less energy for water/nutrient delivery to the plant root	More energy for water/nutrient delivery to the plant root
Soil borne pathogens and pests	Present	None
Above ground pathogens and pests	Present	Present
Supported vegetable types	ALL vegetable types	Root and tuber vegetables rarely supported
Space use efficiency	Less space efficient	Generally more space efficient. Vertical is more space efficient than horizontal
Access to light	Uniform	More non-uniform in vertical hydroponics than horizontal hydroponics. The latter may be as uniform as the geoponic system

Collaborations

We are expploring research collaboration opportunities with Rutgers SEBS faculty including Ilya Raskin, Eric Lam Jim Simon, Paul Tashikov etc. In the photo, Ilya Raskin (2nd from left) and Dave Ribnicky (4th from left) are discussing potential research collaborations with our team

Senior Staff from the Rutgers Dining Services visited the Indoor Cultivation Room B5 on College Farm Road. They liked what they saw!

We have an ongoing collaboration with AERO Development Corp on nutrient maximization in the vertical pod system. Photo shows from L to R: Thomas Gurley (AERO Dev.), Bill Sciarappa (Rutgers Univ.), Frank Fendel (AERO Dev.), Albert Ayeni (Rutgers Univ.) and A.J. Both (Rutgers Univ.)

The Management of Rutgers Makerspace is interested in our Indoor Cultivation initiative and wish to explore some collaboration with us. Photo shows from L to R. Associate VP Shino John (Makerspace), Academic Dean Rick Ludesher (Rutgers SEBS) Albert Ayeni (Rutgers SEBS) Stephen Carter (Makerspace and Lee Pagenkopf (Makerspace)

Summary and Conclusion

- Our Indoor Cultivation initiative at Rutgers SEBS which started in November 2016 is waxing strong and hydroponic production constitutes 80% of what we do.

- Student learning is vibrant with an average of 4 interns per semester learning from hands on projects; and a class enrolment of 12-16 students in the fall semester Indoor Cultivation course that teaches students on state-of-the-art in hydroponic culture

Summary and Conclusion

- Collaborative efforts are growing and the potential is promising in research, teaching and outreach.

- The economics of hydroponics are being studied, and shortly we plan to produce a fact sheet that presents the facts and figures for the public to see the true potential of this important segment of agriculture in densely populated New Jersey

Acknowledgement

- We are grateful to Rutgers SEBS Administration, the Department of Plant Biology, Department of Environmental Sciences, and the Department of Agriculture and Resource Management Agents for supporting the Indoor Cultivation Initiative.
- We also express profound gratitude to all our assistants, interns and students who have worked diligently with us to keep the system running

Questions

For more information please contact:

Albert Ayeni, Ph.D.
Plant Biology Department
Rutgers SEBS
59 Dudley Road, New Brunswick, NJ 08901
aayeni@sebs.rutgers.edu
848-932-6289

Thank You!!!