Title: "Optimizing Information Systems for Sustainable Microgreens Farming"

Grow Smarter, Greener, Together!

"A Thesis Proposal by Geddam Eswar Ajay Chowdary"

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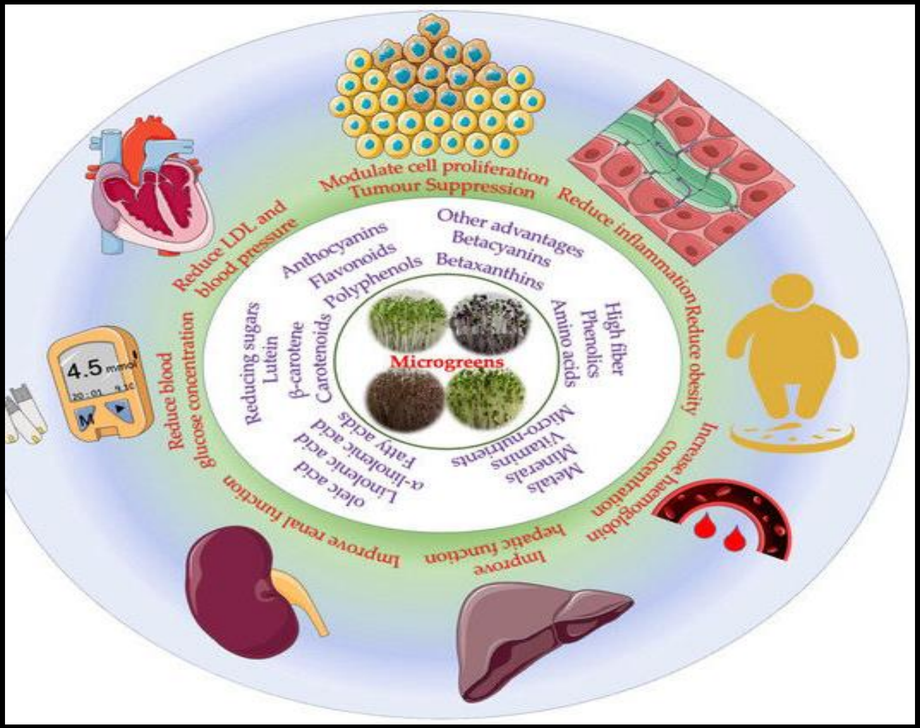
Personal Journey

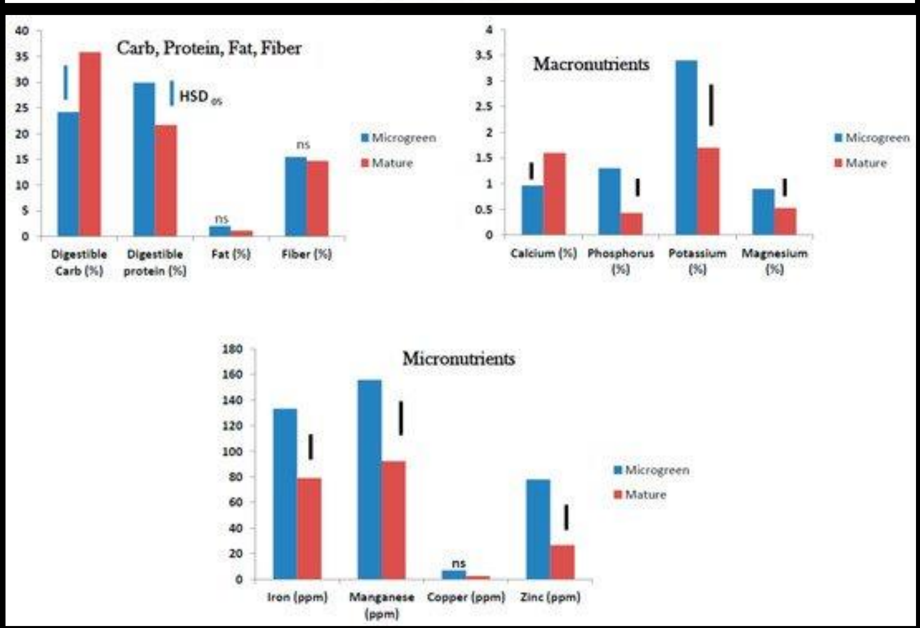
- From India to Harrisburg:
- Grew up seeing industrialization harm food quality in India.
- Family’s microgreens venture sparked my curiosity.
- ISEM at HU: Merging tech with sustainable farming.
- I’m here to fix what I saw break in India let’s make food better for everyone.

Why Microgreens? Why Now?

- Microgreens: Nutrient-rich, perfect for urban spaces.
- Gap: Traditional methods struggle with diseases, efficiency.
- Need: Tech solutions for scalable, safe urban farming.
- The results presented in this experiment indicate that microgreens could provide a means for consumer-access to larger quantities of nutrients per gram plant biomass including macro and micro minerals like P, Mg, Fe, Mn, Zn, S and Cu relative to store-bought mature vegetables.(Di Gioia et al., 2023).

- This gap is our opportunity—let's fill it with tech!

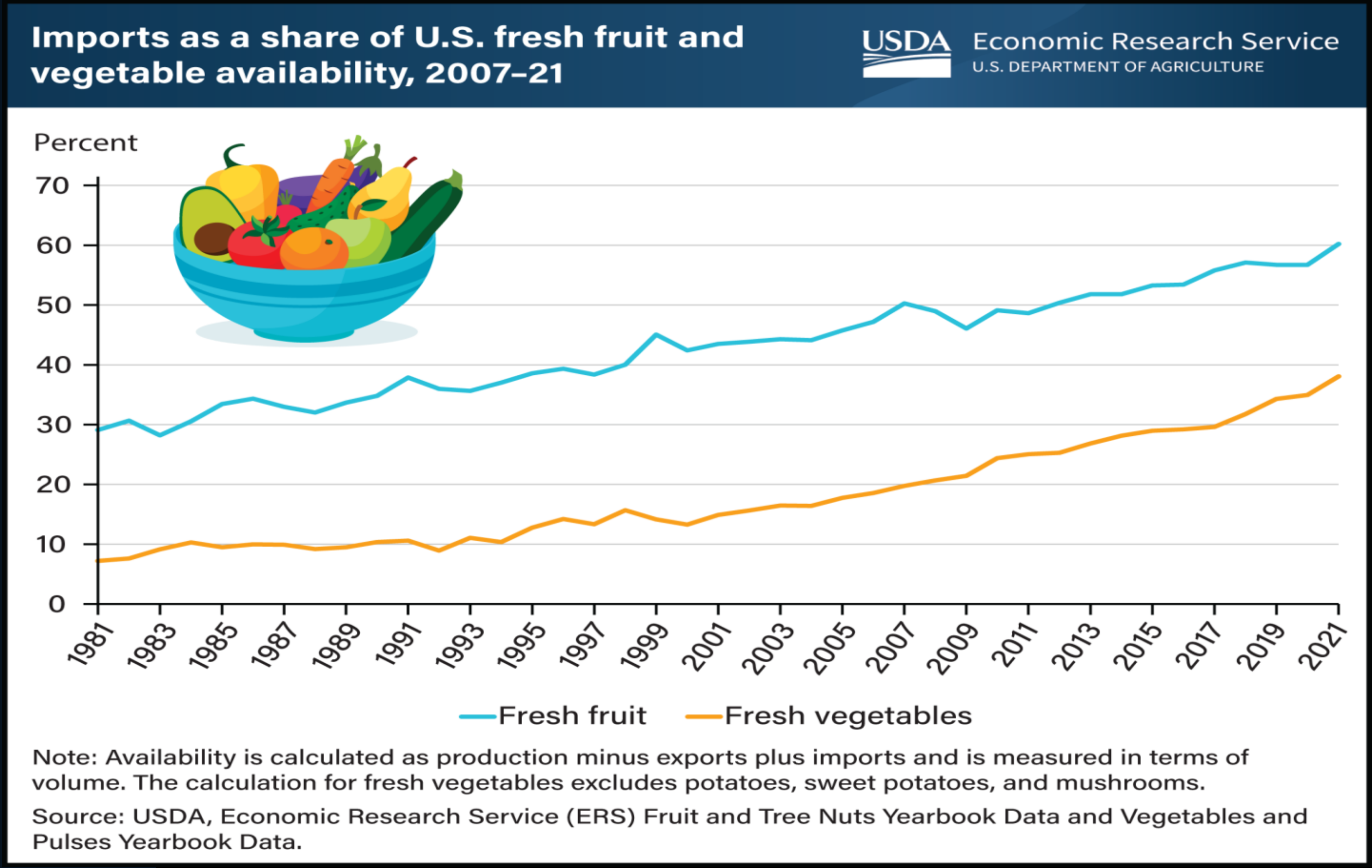




Benefit	Microgreens	Key Nutrients	Unique Factor	References
Immune System	Broccoli, Kale, Radish	Vitamin C, Sulforaphane	Detox + immune activation	Choe et al., 2018; Binder, 2016
Regeneration	Sunflower, Pea, Wheat	Vitamin E, Folate	Cell repair + oxygen boost	Gupta & Rao, 2021; Xiao et al., 2012
Hair	Pumpkin, Cress, Beet	Zinc, Vitamin A	Follicle strength + growth	Choe et al., 2018; Di Gioia & Santamaria, 2015
Skin	Red Cabbage, Cilantro	Anthocyanins, Vitamin A	Anti-aging + repair	Renna et al., 2016; Gupta & Rao, 2021
Energy	Sunflower, Pea, Mustard	B Vitamins, Iron	Metabolism + stamina	Binder, 2016; Di Gioia & Santamaria, 2015
Focus	Broccoli, Watercress	Choline, Nitrates	Brain power + clarity	Renna et al., 2016; Xiao et al., 2012

Urban Food Security

- Rising urban demand for local, fresh produce.
- Smart agriculture: IoT/AI transforming farming.
- ISEM: Systems to solve real-world problems.
- (Evan et al., 2022)



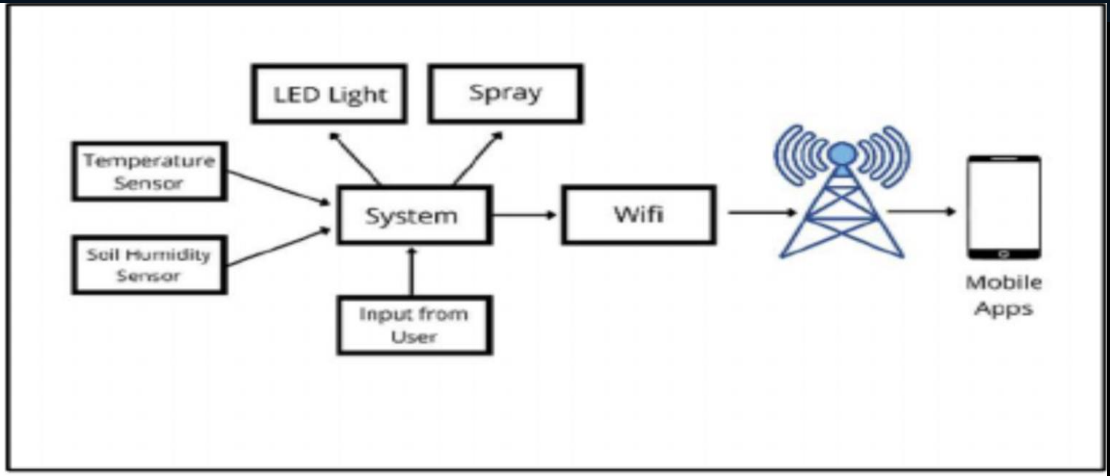
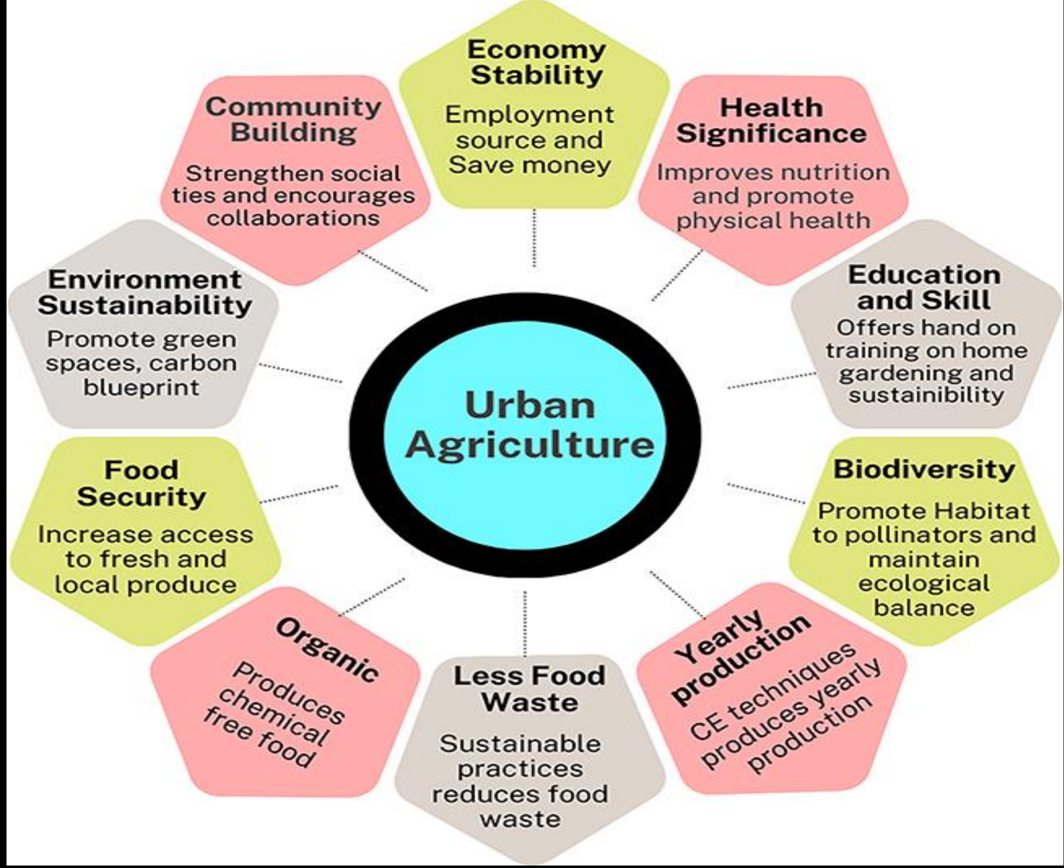
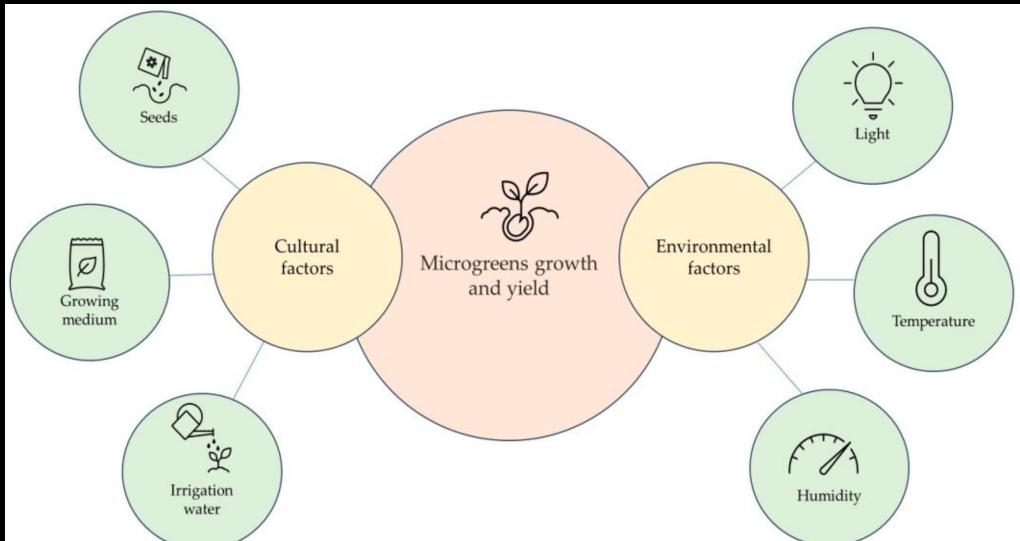


Fig. 11. Block diagram of IoT based indoor vertical farming system

What I'm Asking

- RQ1: How can IoT and AI enhance the nutritional content microgreens?
- RQ2: In what ways do these technologies challenge conventional urban farming practices?
- RQ3: How do they contribute to sustainable cultivation in urban settings?
- Image: A question mark over a microgreens tray with IoT sensors.





What I’ll Achieve

- Evaluate IoT/AI impact on yield, nutrition, sustainability.
- Compare traditional vs. tech-enhanced methods.
- Find scalable strategies for urban microgreens.

What’s Out There

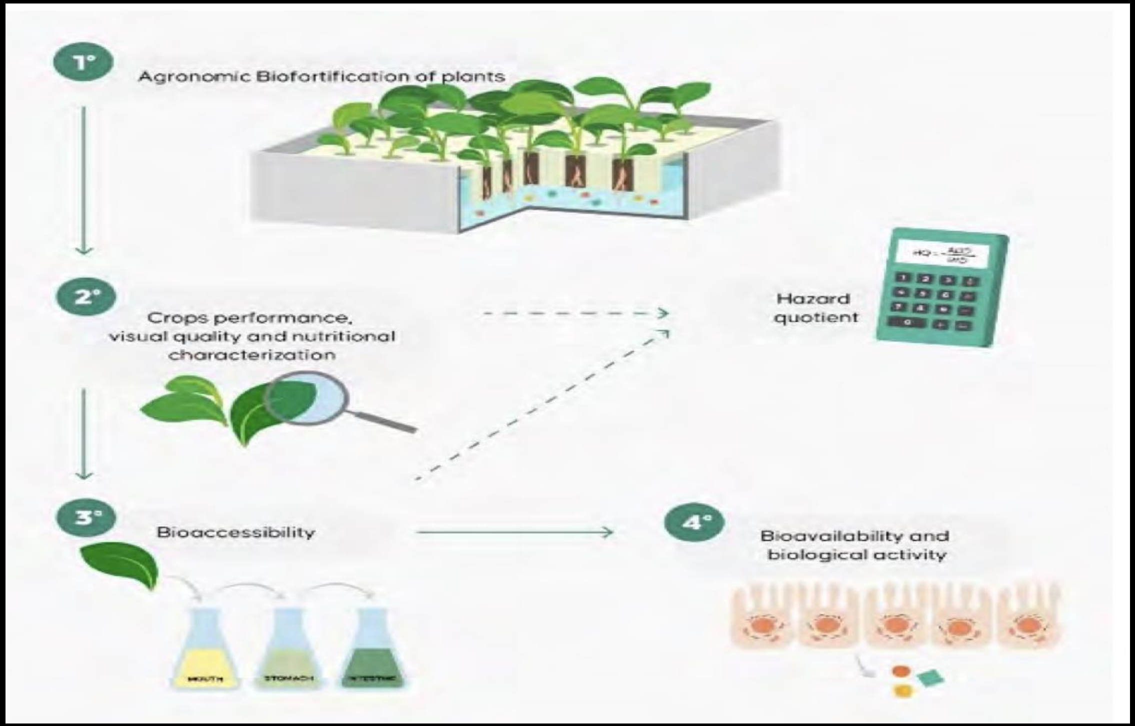
Nutrition: Microgreens on the rise: Expanding our horizons from farm to fork.

Challenges: Assessment of microbial risks in microgreens production: Challenges and solutions"

Tech: Advances in greenhouse automation and controlled environment agriculture: A transition to plant factories and urban agriculture".

Framing My Study

- Nutrition drives demand—tech can enhance it.
- Challenges need solutions—IoT/AI step up.
- ISEM ties it together for urban scalability.



Big Names Guiding Me

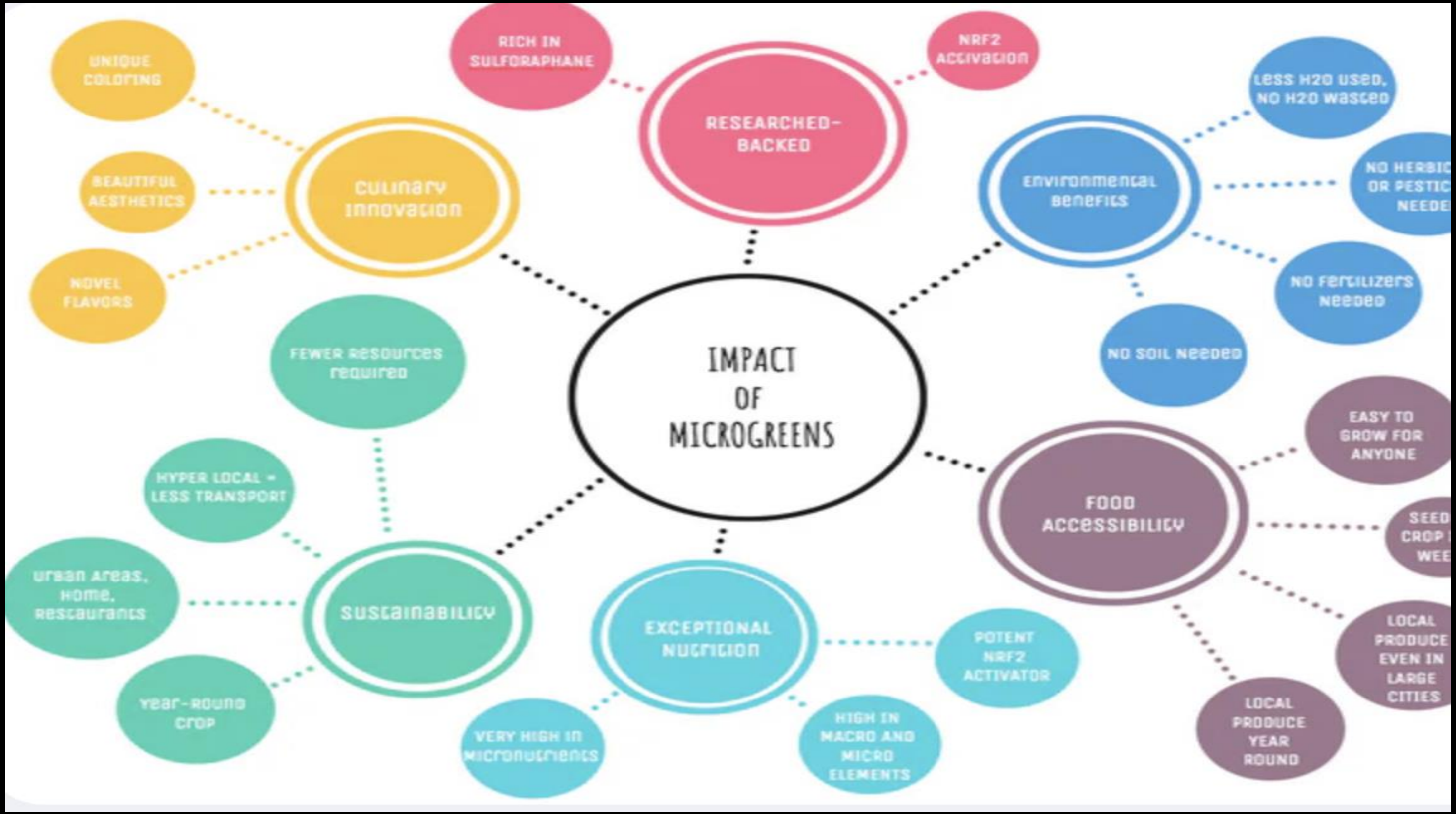
Binder (2016): Microgreens' nutrient edge.

Kim & Park (2022): AI predictive power.

Liakos et al. (2018): ISEM in agriculture.

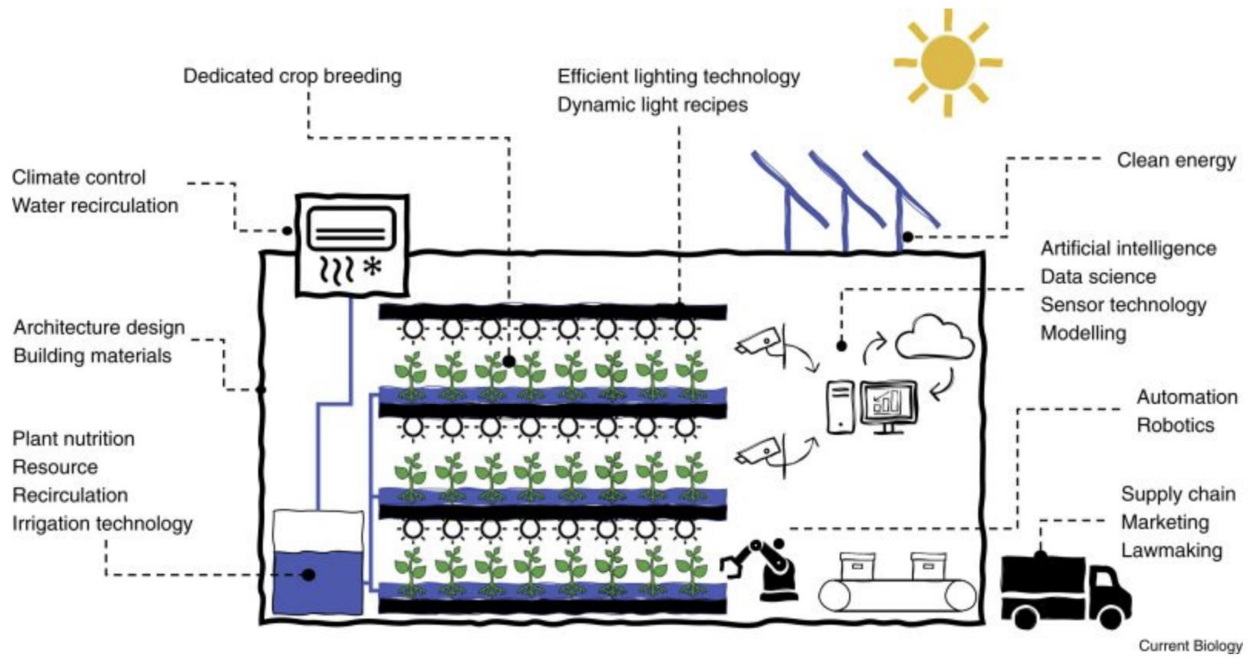
How I’ll Do It

- Convergent mixed-methods: Experiments + farmer insights.
- Pragmatic approach: Real-world solutions.

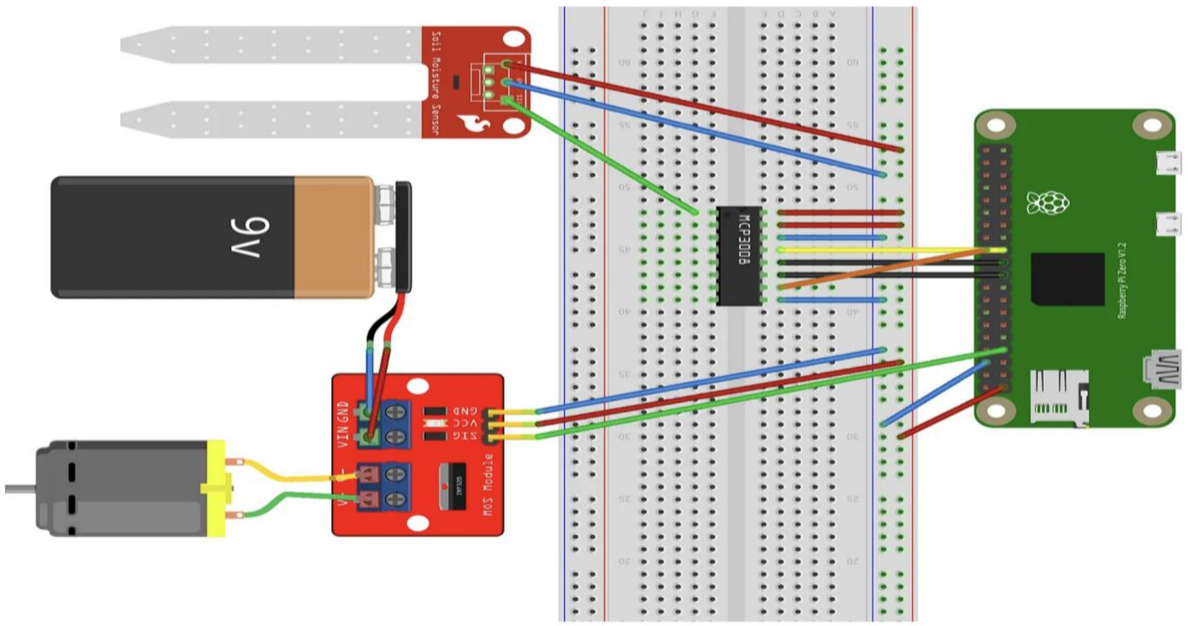


Testing the Tech

- 3 Setups: Traditional, IoT-Enhanced, AI-Optimized.
- Measure: Yield (g/ft^2), nutrition (vitamins), sustainability (water/energy).
- Tools: IoT sensors (DHT22), AI (Python decision trees).



Diagrammatic example of integrated systems



Electronic Circuit for Plant System (Made With Fritzing)

Aspect	Industrial	Household	Grow Kits
Scale	100–1000 sq ft	10–50 sq ft	1–5 sq ft
Sensors	DHT22, TSL2561, CO2, EC, Cam	DHT22, BH1750, PIR, Cam	DHT11, BH1750, Moisture
Controller	Pi 4 Cluster	Pi Zero 2 W	Arduino Nano
Actuators	Misting, LED panels, fans	Pump, LED strip, fan	Mini pump, LED clip
Cost	$1000–$3000	$80–$150	$25–$40 per kit
ISEM Focus	High efficiency, automation	Simplicity, reliability	Ease, empowerment

Micronutrients Chart (Vitamins and Trace Minerals)

Microgreen	Vitamin C (mg)	Vitamin K (mcg)	Vitamin E (mg)	Vitamin A (mcg)	Folate (B-9) (mcg)	Vitamin B6 (mg)	Fe (mg)	Mn (mg)	Zn (mg)	Cu (mg)
Arugula	105.0	165.9	6.4	140.0	114.1	0.14	1.5	0.38	0.47	0.08
Radish	17.2	72.2	0.68	24.7	46.6	0.18	0.54	0.55	0.37	0.09
Fenugreek	29.4	52.9	0.82	35.3	58.8	0.12	1.0	0.47	0.40	0.07
Red Cabbage	64.7	44.7	1.4	58.8	70.6	0.11	0.8	0.29	0.35	0.06
Kale	109.9	235.3	1.8	176.5	76.5	0.15	1.6	0.59	0.50	0.10
Sunflower	23.5	35.3	2.4	47.1	82.4	0.18	2.0	0.71	0.60	0.12
Basil	18.0	414.8	0.8	264.0	68.0	0.16	3.2	1.15	0.81	0.39
Peas	40.0	24.8	0.13	38.0	65.0	0.17	1.5	0.41	0.30	0.18
Cress	69.0	541.9	0.7	346.0	80.0	0.14	1.3	0.55	0.23	0.17
Broccoli	120.0	250.0	1.9	180.0	80.0	0.15	1.7	0.60	0.41	0.05
Amaranth	50.0	150.0	1.2	120.0	60.0	0.11	2.5	0.35	0.50	0.08
Cilantro	27.0	310.0	2.5	337.0	62.0	0.15	1.8	0.43	0.50	0.23
Chai Seed	10.0	20.0	0.5	15.0	30.0	0.08	7.7	0.20	4.58	0.92
Basil Seed	12.0	25.0	0.6	20.0	35.0	0.09	8.0	0.25	4.60	0.90
Marigold	30.0	80.0	0.9	50.0	40.0	0.10	1.2	0.30	0.25	0.06
Mustard	70.0	200.0	1.0	100.0	55.0	0.12	1.4	0.45	0.35	0.07
Nasturtium	65.0	180.0	0.8	90.0	50.0	0.11	1.3	0.40	0.30	0.06
Turnip	21.0	50.0	0.5	30.0	45.0	0.09	0.9	0.35	0.27	0.10
Wheatgrass	35.0	100.0	1.1	60.0	38.0	0.13	2.4	0.50	0.40	0.05
Swiss Chard	30.0	830.0	1.9	306.0	14.0	0.10	1.8	0.37	0.36	0.18

Macronutrients Chart (Minerals Needed in Larger Amounts)

Microgreen	Ca (mg)	K (mg)	Na (mg)	Mg (mg)
Arugula	160	369	27	47
Radish	38	259	52	20
Fenugreek	50	300	20	30
Red Cabbage	45	280	30	15
Kale	200	450	38	47
Sunflower	78	320	10	60
Basil	177	295	4	64
Peas	25	244	5	33
Cress	81	606	14	40
Broccoli	190	470	33	50
Amaranth	215	350	20	65
Cilantro	67	521	46	35
Chai Seed	631	407	16	325
Basil Seed	220	420	10	300
Marigold	90	260	15	25
Mustard	115	384	20	40
Nasturtium	100	370	12	35
Turnip	30	191	67	15
Wheatgrass	43	300	10	50
Swiss Chard	51	379	213	29

Hearing from Farmers

- Survey: 20 urban farmers, 5-point Likert scale.
- Interviews: 10 farmers, semi-structured (TPB framework).
- Focus: Adoption barriers, tech benefits.
- Here is the survey form:

https://forms.office.com/r/eUs2UBqxhF?origin=lprLink

Crunching the Numbers

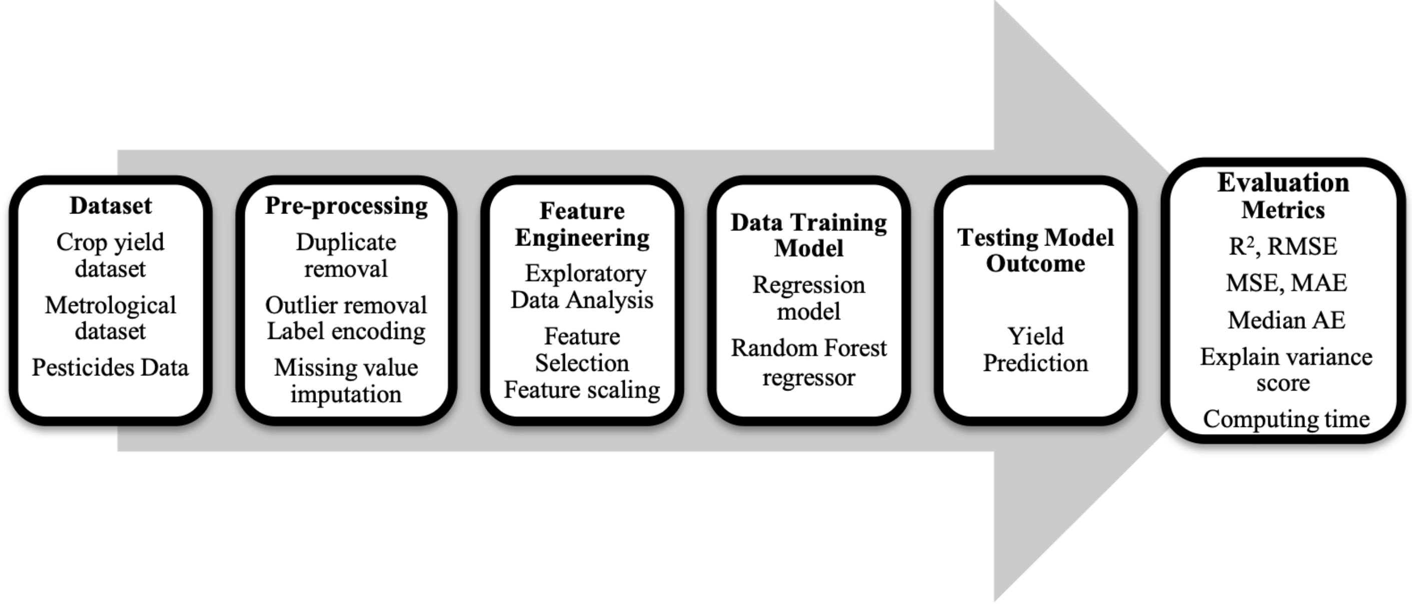


Figure 1 Architectural diagram

- Quantitative: ANOVA for experiments, regression for predictions.
- Qualitative: Thematic analysis in NVivo (e.g., ‘disease concerns’).
- Outcome: Scalable tech framework.

What This Means

- 20-30% higher yields, better nutrition with AI.
- 50% less disease, 40% less water/energy.
- Scalable model for urban food security.

Getting It Done Tim eline:

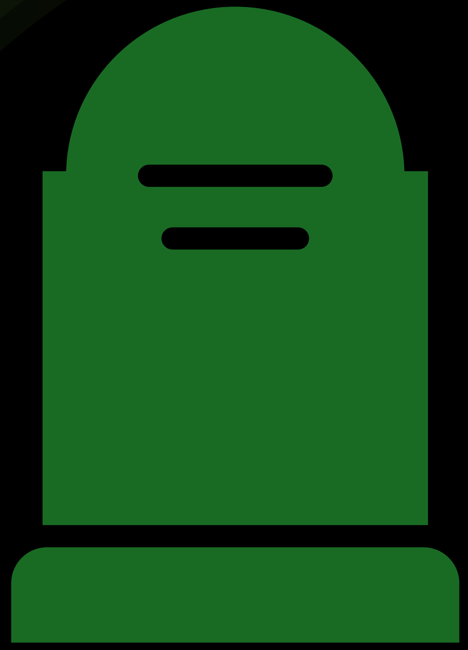
Future Timeline:

Apr 2025: Topic approval.

May : Setup experiments, start surveys.

June: Analyze data, submit final draft(July).

What’s Next?



- Capstone (ISEM 699): Test more varieties, blockchain for supply chain.
- Long-term: Affordable tech for wider adoption.
- Image: A futuristic microgreens farm with IoT and blockchain icons.

Why This Rocks

- Solves real problems: nutrition, sustainability, scalability.
- ISEM in action: Tech + management for urban farming.
- Let’s make food greener—together!
- Image: You smiling with a microgreens tray.

Reference

- Page –2 :Image: A split photo on left: Rural Indian farmland(https://www.newrootsinstitute.org/articles/intensive-agriculture
-); right: microgreens tray at home(https://ohnene.be/our-microgreens-grow-room-setup/).
- _Page-3 *Figure - PMC*. (n.d.). https://pmc.ncbi.nlm.nih.gov/articles/PMC9864543/figure/molecules-28-00867-f002/(article_site)
- Di Gioia, F., Hong, J. C., Pisani, C., Petropoulos, S. A., Bai, J., & Rosskopf, E. N. (2023). Yield performance, mineral profile, and nitrate content in a selection of seventeen microgreen species. *Frontiers in Plant Science*, *14*. https://doi.org/10.3389/fpls.2023.1220691(last sentence).
- Page-3 second image (Ayeni, A. (2022, January 28). *Micro/Baby-Greens and mature field grown vegetables*. https://encyclopedia.pub/entry/18937)
- Page-4 (Evan, F., Anisa, N., Nurfitriyani, S. J., & Alexandra, J. (2022). IoT architectural design for microgreens cultivation. *2022 International Conference on Information Management and Technology (ICIMTech)*, 225–230. https://doi.org/10.1109/icimtech55957.2022.9915013)
- Page-4(*Imports make up growing share of U.S. fresh fruit and vegetable supply | Economic Research Service*. (n.d.). https://www.ers.usda.gov/data-products/charts-of-note/chart-detail?chartId=107008)
- Page-8 (https://nutrage.it/wp-content/uploads/2024/06/BOOK-OF-ABSTRACT-20240514_web.pdf) 2ns image.

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