Farmony | RADIX

Beginner's Guide

September 2020

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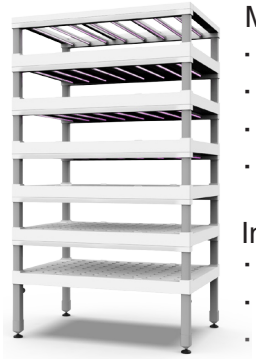
The RADIX
Styles

Types of RADIX

The Propagation and Vegetative modules work in conjunction to promote the best leafy green growth. We separate growth stages into different modules for differentiation on light spectrum, bed to light distance, and plant density as well as differing nutrient levels, light duration, and environmental conditions.

Propagation RADIX



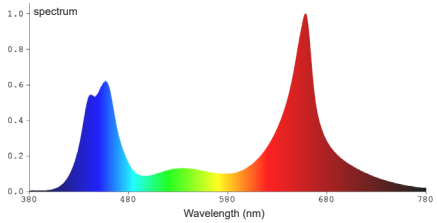
Standard Module
6 layers at 2.67 m / 8' 9"

Main Features:

- Nursery stage growth for compact and sturdy leaf development
- Dense planting pattern: 360 plant site capacity per grow bed
- Deep Flow Mode of 30L | 8 gal per grow bed
- 18+ hour light cycle

Includes:

- 8 light bars per layer (11.5 Watt each)
- Early growth light spectrum
- 25 cm light to bed distance
- 180 hole rafts



Vegetative RADIX

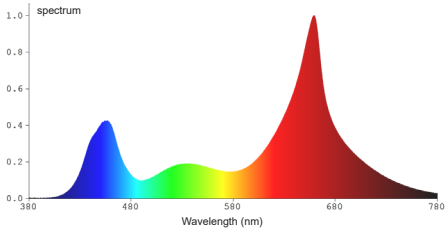
Standard Module
5 layers at 2.54m / 8' 4"

Key Features:

- Light spectrum to maximize size and weight of full-size crops
- 108 plant site capacity per grow bed for whole head or herb production
- Shallow Flow Mode of 15L | 4 gal per grow bed
- Anticipated 14-15 hour light cycle

Includes:

- 8 light bars per layer (13.5 Watt each)
- Mature growth light spectrum
- 30 cm light to bed
- 54 hole rafts



RADIX Ratio

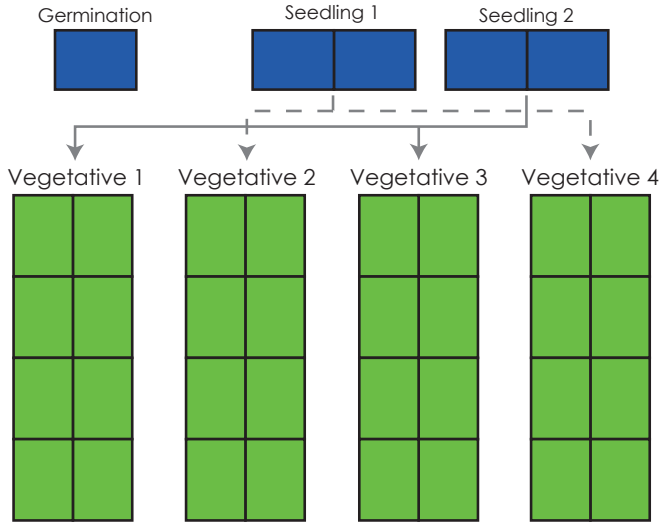
The ratio of standard Propagation to Vegetative modules is:

Propagation : Vegetative

1 germination + 8 seedling : 62 vegetative

This ratio varies depending on the number of layers in each module, plant density, duration of each stage, and expected loss rate.

Small Farm with Standard Ratio

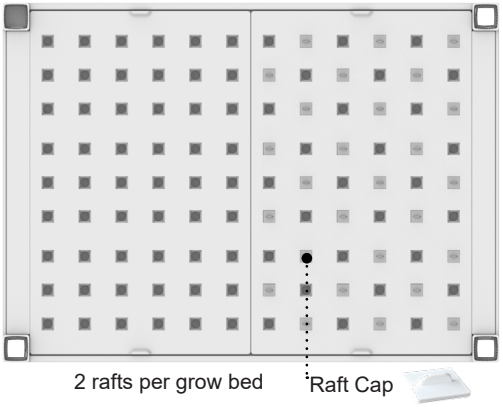


We recommend grouping modules into separate zones in each stage to increase operational efficiency and decrease cross-contamination.

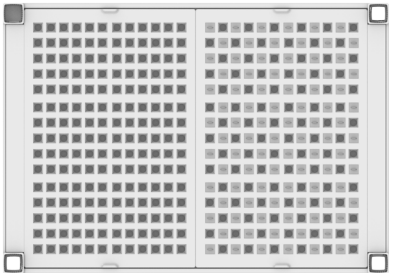
The RADIX
Accessories

Rafts

Rafts provide structural support for the plants and come in two options designed for the different growth stages. Raft caps are used to cover unused plant sites. This provides flexibility to meet the needs for different plant growth habits.



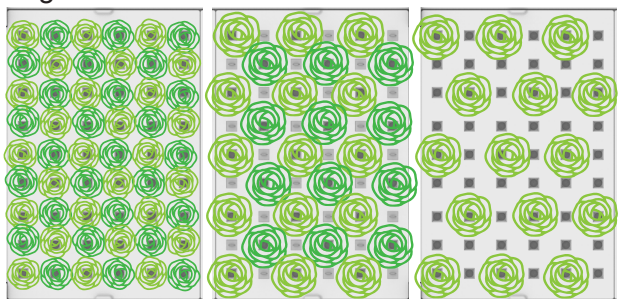
Propagation Rafts



180 plant sites per raft

Designed for nursery stage where plants need less space

Vegetative Rafts

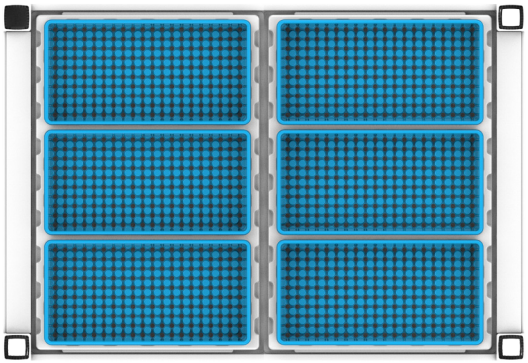


54 plant sites per raft

For full grow-out of mature leafy greens like whole-head lettuce and herbs
Lighting optimized for fast leaf growth

Trays

Trays are used to diversify crop selection with small, fast growing microgreens and baby leaf mixes. Our baby leaf and germination trays are a sturdier version of the industry standard 10x20 tray made for repeat use with the RADIX.



Baby Leaf Tray (blue)

Perforated trays used to hold growing media and plants. Trays sit in holders above the water level to reduce algae growth on media and promote healthy roots.

Germination Tray (black)

Solid trays to retain moisture and promote even germination.

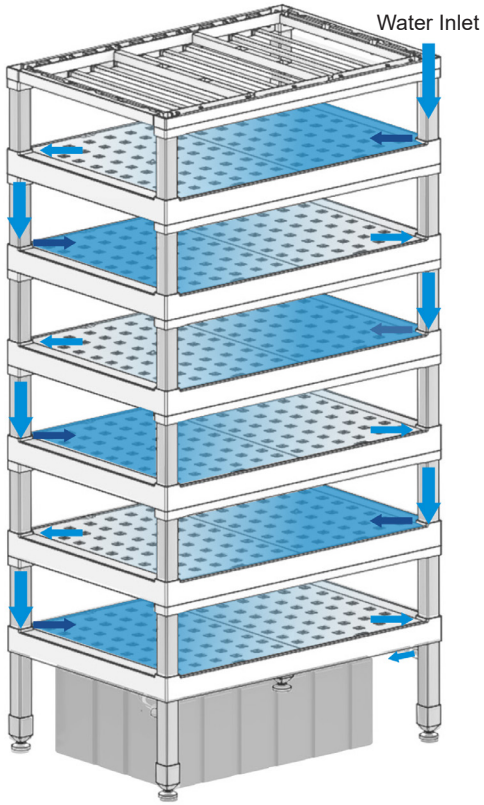
Blue Light Bar

Convert any vegetative module to maximize anthocyanin production in red varieties with a proven peak at 450nm. Simply replace alternating VE lights with Blue Lights via quick-connectors. This allows flexibility to adapt an entire module or single grow bed.

The RADIX
Water Flow

Water Flow in Module

The RADIX is designed for constant water recirculation. External plumbing delivers water to the top of each module which travels through the grey spacers from grow bed to grow bed. Exterior plumbing takes water from the module's outlet to the under module reservoir where it is returned to the top of the module or to a nutrient dosing tank.



Features

- Recirculating nutrient solution
- Integrated water flow
- Built in aeration:
  Maintains dissolved oxygen levels of 4-5 ppm per grow bed
- Flexible water levels and flow patterns

Water Flow Numbers

Flow Rate:
3.78 L / 1 gal. per minute per module

Grow Bed Volume:
Deep Flow Mode: 30 L / 8 gal. per grow bed
Shallow Flow Mode: 15 L / 4 gal. per grow bed

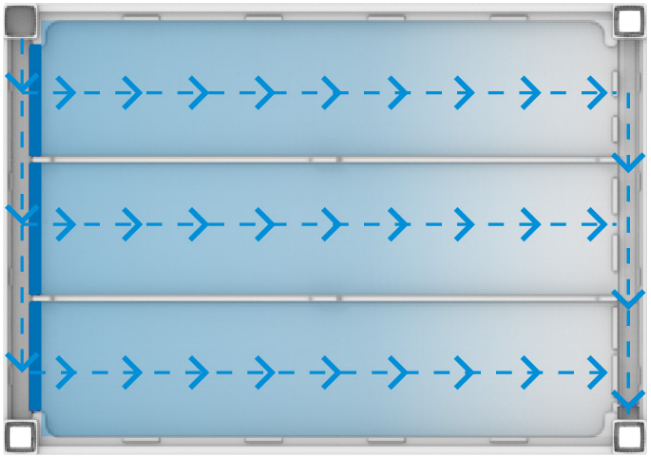
*The height of the Retaining Dam at the Outlet is what controls the height of water in the grow bed.

Water Flow Accessories

Flow Regulator Long | Flow Regulator Short | 25mm Retaining Dam | 12mm Retaining Dam | Filter - only 1 per module

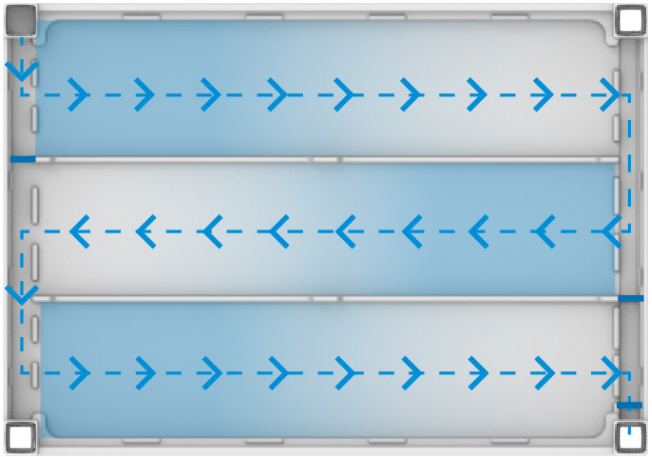
Water Flow in Grow Bed

Propagation: Deep Flow Mode



Deep Flow Mode: 3 Flow Regulators + 1 25mm Retaining Dam
This flow pattern is referred to as E Pattern Flow

Vegetative: Shallow Flow Mode



Shallow Flow Mode: 2 25mm + 1 12mm Retaining Dams
This flow pattern is referred to as Z Pattern Flow

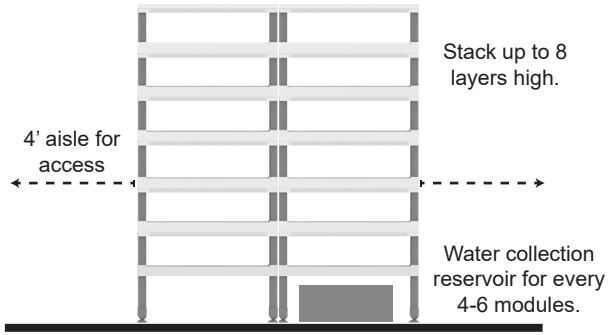
The RADIX
Module Formation

Configurations

As a modular unit, the RADIX can be arranged to fit any growing space. The RADIX is most commonly situated in double rows to achieve maximum grow space, but is customizable to meet operational goals. Factors that we consider when selecting a layout are:

- In what type of building will the grow be installed?
- What is the facility shape? Rectangular or narrow, linear?
- Is the operation for commercial production, education, research, or community display?
- Are you using hydroponic or aquaponic nutrient?
- How many layers would you like to grow on?
- What crops will be grown?
- What is your desired output volume?
- Is the end product a whole plant or packaged mix?
- Who will be operating the systems? Students in a school, adults in a commercial operation, or necessary worker accommodations?
- What level of automation will you seek? Automated nutrient dosing, seeding machines, or havesting and cleaning equipment?
- Will there be mechanical transportation assistance such as scissor lifts or conveyor belts, or manual transportation?

Design Requirements



Single Row

- Ideal for small or narrow facilities
- Access to both sides for in-place harvesting
- Increased canopy airflow
- Reduced micro-climates
- Easy access for researchers or student growers

Double Row

- Ideal for large-scale commercial production
- Maximize grow space and yield per square foot
- Maximize light usage
- Create simple footprint for easy replication and scalability
- Clear and defined zones for simple crop management

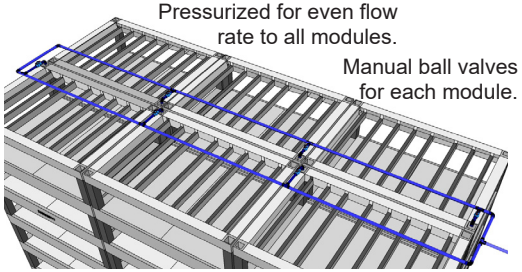
The RADIX
Plumbing & Nutrient Management

Plumbing Basics

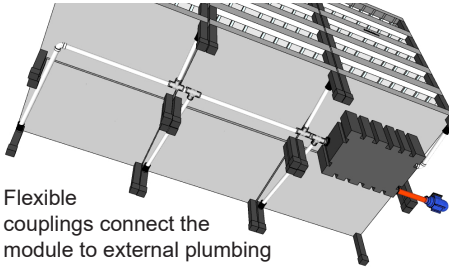
Connecting exterior plumbing to the RADIX is simple, but can be complicated depending on operational goals and equipment. Plumbing design is linked with the nutrient management system. Nutrient management is one of the first processes to automate when growing hydroponically. The RADIX easily integrates with many commercially available nutrient management platforms. Factors that we consider when designing plumbing:

- Will you have a separate tank room?
- How many modules can be in a row?
- What crops will you be growing?
- Number of crop zones?
- Number of separate tanks for contamination prevention?
- Harvest and cleaning schedule?
- What nutrient will you use?
- How will you get fresh water to the modules/reservoirs?
- Where is the water source located?
- What is the facility's incoming and outgoing water capacity?
- Are their floor drains?
- What is the quality of the sourcewater? PPM, pH, alkalinity, chlorine?
- Will you clean and recycle used nutrient solution?
- Does your municipality require water treatment prior to disposal?

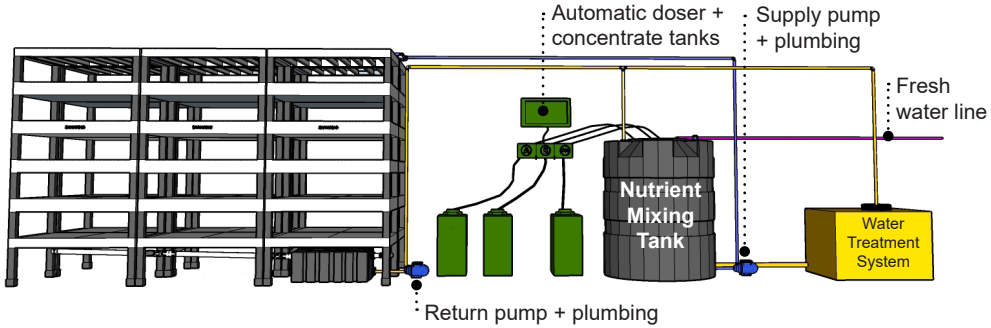
Water Distribution Loop



Drainage Collection

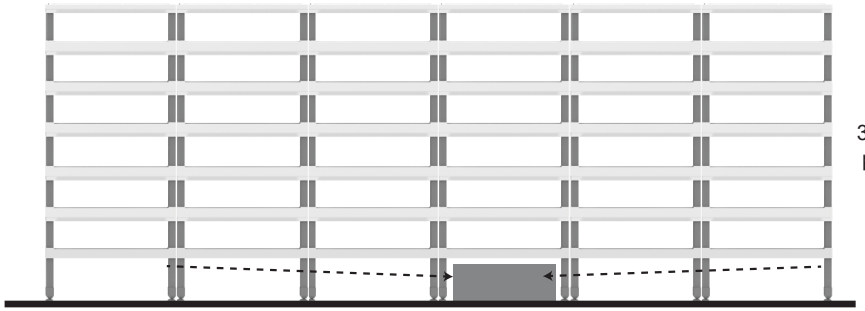


Integrating Automatic Dosing



Design Requirements

Single Row

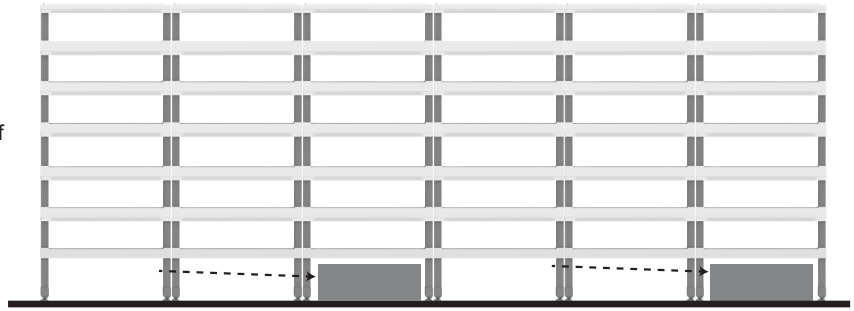


Water collection reservoir for every 4-6 modules.

3% minimum slope of plumbing from outlet leg to reservoir.

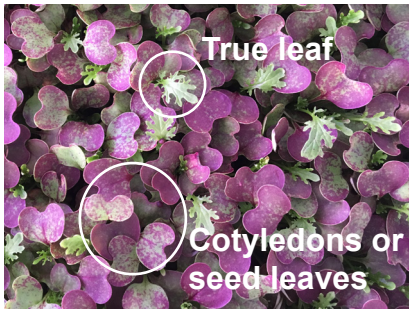
Maximum height of reservoir is 34 cm.

Double Row



RADIX Process
Types of Crops

Microgreens
Microgreens are immature plants harvested just past the sprouting stage. Microgreens are popular among growers because they are quick producers often ready to harvest in 7 to 21 days. A crop is ready for harvest at a height of 2-5 cm. Microgreens are popular among high-end chefs and foodies because of their strong flavor and high nutrient content.



Harvest when cotyledons are 1-2 cm


Live tray of Celosia for restaurant sale


Microgreen mix in 2 oz clamshell for retail

Baby Leaves
Baby leaves are immature plants harvested when leaves are between 5-13cm when they are most tender. Baby leaves are most commonly grown and packaged for Ready-to-Eat mixes. Premade mixes are the most commonly desired product.
Baby leaves can be grown in the RADIX using raft or tray production.


Baby leaf Tatsoi in Vegetative Raft


Baby leaf growing in trays


Baby leaf mix

Whole Head
These are full-size crops grown to maturity and harvested as a single unit. These crops are popular with growers because are the best value for weight. However, many high-end retail and food service vendors prefer premade mixes to whole heads. Whole head lettuce specifically grown for salad mixes are called classified as “multi-leaf”.


Whole head bok choi ‘Red Pac’


Hydroponic gold standard ‘Rex’ butterhead


Multi-leaf Salanova ‘Green Oakleaf’

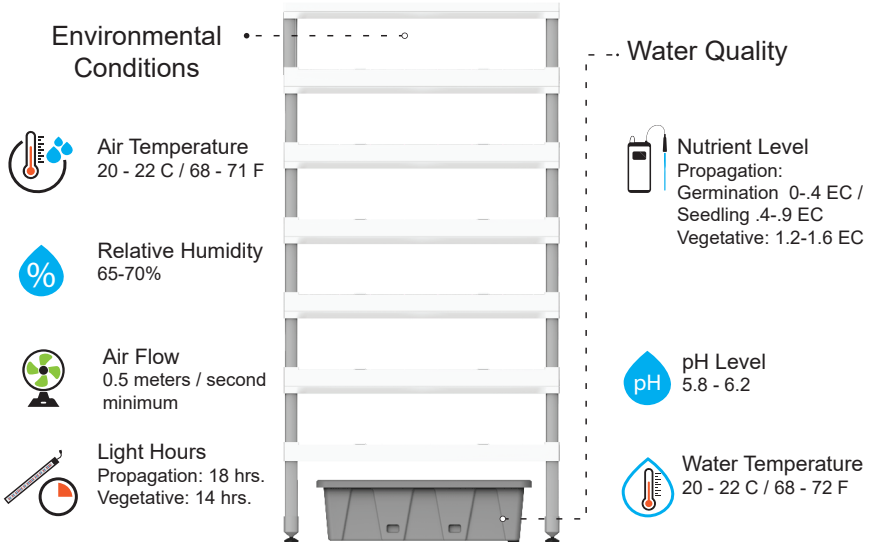
RADIX Process
Crop Cycles for Raft Production

Understanding the Growing Process

We divide the growing process for baby leaf and full-size greens into stages based on time spent in propagation and vegetative modules. Each phase of growth requires different environmental conditions and water quality for best results. These conditions are often best met by using separate modules, plumbing, and rooms though size of operation and labor are factors to consider.

These timelines represent a standard cycle for the most common crops grown in vertical farms. This graphic connects the time spent in each stage to the necessary steps required for labor planning. We intend these recommendations as a starting point for RADIX beginners. We encourage growers to experiment with all modular components and processes to find what best meets operational needs.

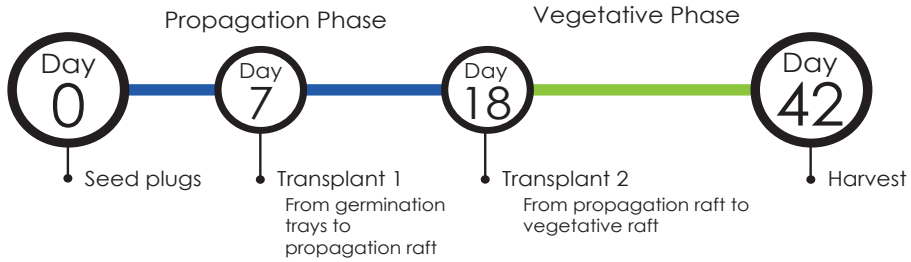
Growing Conditions



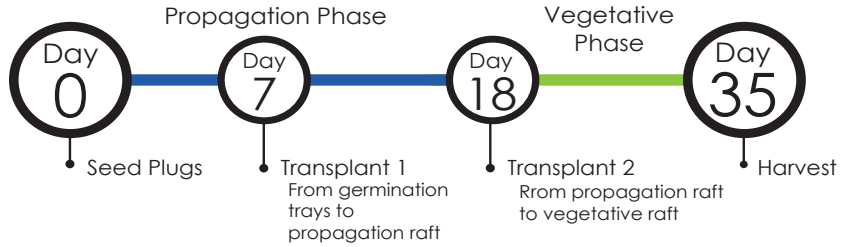
*The relationship between air temperature and relative humidity is referred to as Vapor Pressure Deficit (VPD). Please consult a VPD chart for the optimal conditions for your facility.

Most Common Crop Cycles

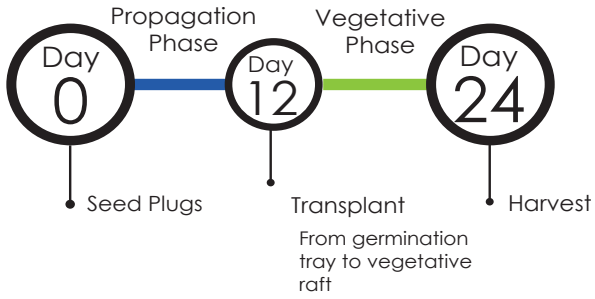
Whole Head Lettuce



Basil



Baby Kale / Arugula



RADIX Process

Standard Process for Raft Production

Farmony

Process Flow

1 Germination

Duration: 7-9 days

Water Flow: Flood & drain: every 2-4 hours for 15 minute cycles with z pattern accessories and no outlet dam.

2 Seedling

Duration: 10-12 days

Density: 90 plant sites in seedling raft

Water Flow: Constant flow @ 3.78 L (1 gal) per minute

3 Vegetative

Duration: 22-26 days

Density: 27 plant sites in vegetative raft

Water Flow: Constant flow @ 3.78 L (1gal) per minute

4 Harvest

Harvest at 42-50 days from seeding

Labor Process

1 Seeding

Follow manufacturer instructions to prepare substrate for seeding.

Place 1 seed per plug

Place seeded trays with drainage holes into the Radix.

Set pump timer to cycle water for 15 minutes every 2-4 hours

2 Move 1

Place raft caps into seedling raft covering every other plant site.

Remove plug from germination tray.

Place plug into plant site making sure that the substrate is secure and that roots fit through the opening.

3 Move 2

Place raft caps into vegetative raft covering every other plant site.

Remove plug from seedling raft, dip into a clean cup of water to gather roots.

Place plug into open plant site with all roots fitting through the opening.

Insert raft into grow bed starting at the top and work down.

4 Harvesting

Remove rafts from module, starting from the bottom and working up.

Place raft on clean work surface.

Use a clean knife or scissors to cut the base of each plant above the substrate.

Place produce into a clean harvest container.

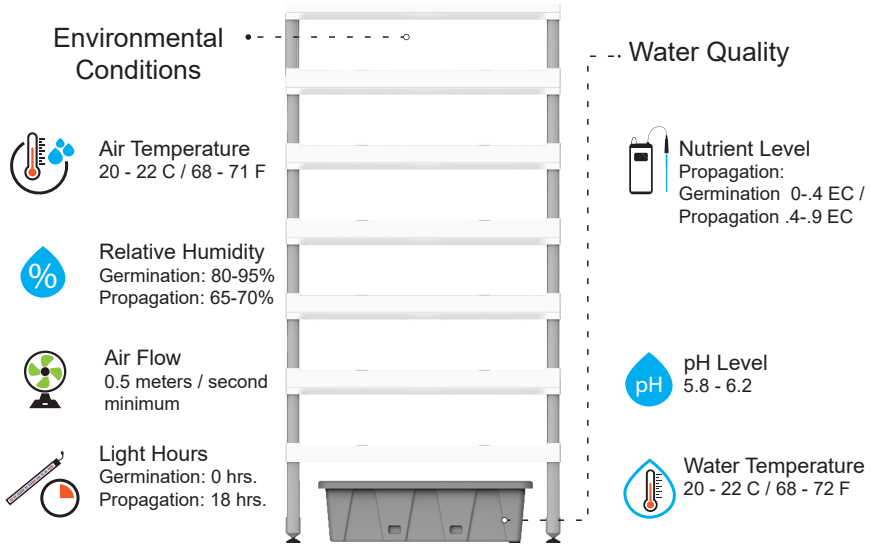
RADIX Process
Crop Cycles - Microgreens

Understanding the Growing Process

Microgreen production follows a quick and simple process. Trays are seeded and germinated outside of the Radix in an acceleration chamber or room which enables quicker and more even germination. Trays are moved to the Radix to complete the grow cycle when roots are long enough to reach the water level.

Grow times and seeding density vary based on crop type. We group microgreens into three categories based on grow times: quick, average, and slow growing. Seeding density generally follows these categories. Quick growers have larger seeds which germinate and reach harvest size sooner than slow growers which have a longer process. We have listed examples of greens that fit into each category, but we always recommend that growers experiment with local seed available.

Growing Conditions



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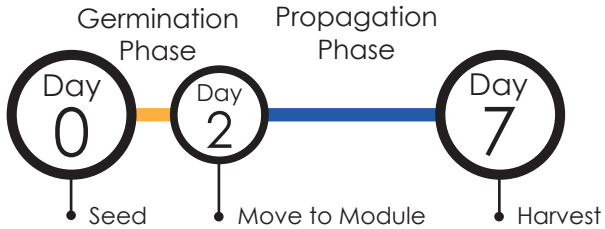
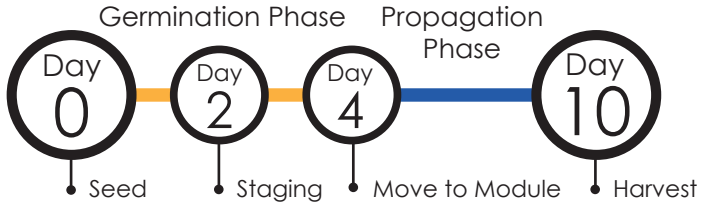
Most Common Crop Cycles

Quick Growing



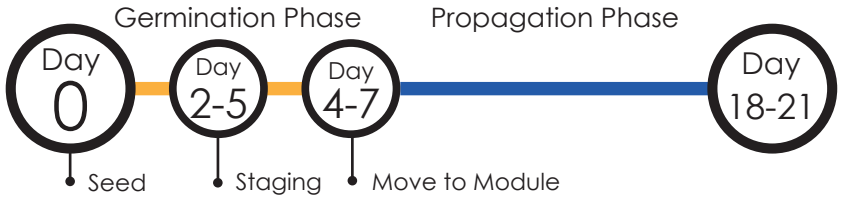
Examples:
Radish, sunflowers, pea shoots, corn shoots, buckwheat

Average Growing



Examples:
Arugula, cabbage, choi, kale, mustard greens

Slow Growing



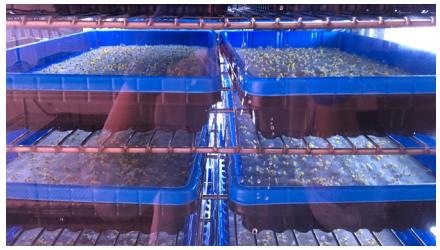
Examples:
Amaranth, basil, carrots, celosia, chard, cilantro, cress, basil, dill, scallions, shiso

RADIX Process

Tray Production - Standard Process for Microgreens

Process Flow

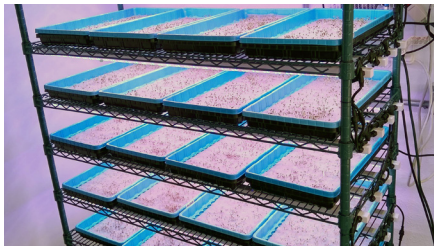
1 Germination



Duration: 2-5 days

Placement: In germination chamber
OR on heat mats with tray cover

2 Staging



Duration: 2 days

Placement: On empty raft in RADIX
OR on mobile shelf

3 Grow Out

Duration: 7-15 days

Water Flow: Constant flow @ 3.78L (1gal) per minute

4 Harvest

Harvest when stems are 4-6 cm and cotyledons are 1-2 cm.

Labor Process

1 Seeding

Wet mat and lay flat in blue tray.

Scatter seeds evenly across mat.

Fill black tray with 2L of fresh water. Place blue tray in black tray.

Place tray in chamber or on heat mat to germinate.

2 Move 1

Remove trays from chamber when 75-90% of seeds have germinated.

Roots must have minimum 1 cm of growth emerging from blue tray to put into Radix.

Place trays under light source until roots are ready.

3 Move 2

Insert tray holders into grow bed.

Remove blue tray from black tray. Place blue tray into tray holder.

Place trays from back to front to avoid dripping water on seeds.

4 Harvesting

Remove trays from module. Avoid dripping on other trays.

Place trays on clean work surface.

Use a clean knife or scissors to cut 1 cm above the substrate.

Place produce into a clean harvest container.

RADIX Process
Cleaning the RADIX

Farmony

The Broad Picture

Food safety is the primary concern of all vertical farms and should be considered during the design phase as to maximize efficiency at every step. Cleaning is a major factor in establishing and maintaining food safety and typically consumes 30-40% of labor hours. The physical process of cleaning grow and harvest equipment comprise the bulk of this time, but monitoring, verifying, and documenting the practices are also necessary.

Every farm will develop its own practices based on growing method and customer standards. We recommend that all farms begin with the practice of cleaning between every crop cycle in order to understand the full process and set baseline standards via lab sample analysis for later comparison. This ensures that a farm begins operation with best plant health possible. This leaves space for farms to change their practices and adapt as the operation matures and operators become more familiar with the process and what works for their chosen crops.

Clean-In-Place Process: Modules, Plumbing, and Tanks

When possible, we suggest plumbing design for a facility to use a Clean-In- Place (CIP) cycle in which cleansers and sanitizers are able to circulate through the plumbing, tanks and modules with the least amount of human involvement. A CIP process is the most labor efficient way to control biological levels and biofilm accumulation. This saves labor, but requires more intentional plumbing design which is often more costly.

PREPARE 1

Gather all necessary cleaning tools before beginning.

Remove all rafts, trays, and light barriers

Manually remove all debris: roots, leaves, substrate, and salt build-up.

DRAIN 2

Open up / connect to drain line.

Turn off water supply pump.

Starting at the top, remove all water accessories from one grow bed at a time.

Let each layer drain 2-5 minutes before moving down to the next grow bed.

CLEAN 3

Remove remaining water with wet vacuum.

Use a soft cloth to wipe down grow beds and legs with food grade cleaning agent.

Scrub with light scouring pad where and when necessary.

SANITIZE 4

Insert clean 25 mm retaining dam at each grow bed outlet.

Fill with fresh water and turn on water supply pump.

Add sanitizer. Allow solution to cycle for the period of time suggested by chemical manufacturer. Verify correct chemical levels

Drain sanitizing solution following the draining process.

REFILL 5

Rinse with fresh water until water tests at approved level.

Insert clean water flow accessories.

Refill with nutrient solution.

Food Safety Overview

Following Regulation

- Federal: Food Safety Modernization Act (US)
- Local licensing: Raw Agricultural Commodies vs processing
- Customer requirements often dictate facility certifications and product labeling

Culture of Food Safety

- Always #1 priority - facility design and daily practices
- Good Agricultural Pactices (GAP) and Good Handeling Practices (GHP) are key - humans are usually the main source of contamination
- Designate a food safety director when possible and support their training and efforts.
- Set clear expectations and create transparent processes so entire company from CEO to operators are on the same page.

Labor Training

- Require workers to get Food Handler's certification from local program.
- Create site specific protocols and training that integrate hydroponic methods with GAP.
- Designing workflow with multiple checkpoints that processes are followed correctly

RADIX Process
Cleaning Accessories

3 Step Process

The cleaning process is comprised of three steps: clean - rinse - sanitize. Anything that is a Food Contact Surface (FCS) must go through the whole cleaning process. FCSs are anything that come in physical contact with the end product. Rafts, raft caps, trays, and light barriers are all Radix components that are considered FCSs. Grow beds are not considered FCSs so they may be a different process for cleaning and sanitizing that is not as rigorous for human health but is created for best plant health and water quality.

PREPARE 1

Manually remove raft caps, substrate, and plant debris.

Prepare cleaning agent and water in soaking containers appropriate to fit the accessory.

CLEAN 2

Chemical: Soak equipment in a food safe cleanser. Soaking the trays helps to loosen up any remaining debris and makes the mechanical cleaning more effective.

Mechanical:
Manually scrub trays and small accessories with a medium to hard bristle brush to remove any remaining debris and to break the biofilm.

Rafts and light barriers can handle the use of a pressure sprayer.

SANITIZE 3

RINSE the trays in fresh water to remove all visible debris. Tip* if you can still see roots or algae then the item is not clean!

Sanitize: Dip or soak equipment in sanitizer following manufacturer's specifications. Equipment must be in full-contact with solution for a specific amount of time that varies by product.

STORE 4

Store sanitized equipment on designated racks or plastic pallets.

Pallets and racks used for clean storage must follow the same cleaning and sanitizing procedures as other food contact equipment. All equipment should be stored in a clean environment. Cleaning tools should have a dedicated clean storage area where they can hang and dry out until use again.

Tips & Suggestions

- Keep raft caps separate from water flow accessories during cleaning process.
- Stack rafts and trays in a way that they are able to fully dry within 1-2 days to avoid growing bacteria.
- Storage carts should be kept 4" away from the wall and the bottom shelf 6" above the ground.
- Note the weight capacity of mobile storage as stacked rafts get very heavy.
- Clean and dry any equipment before storing long-term.

Cleaning Considerations

Clean Storage

Clean storage is an often overlooked necessity that quickly becomes a challenge during operation. We recommend planning dedicated space for dirty and clean accessories into the farm design to aid in effective work flow.

Clean equipment must be stored on clean plastic pallets or mobile carts. We recommend sourcing carts that are NSF certified for water contact and high humidity environments. Chrome racks will rust and are not acceptable for food processing facilities.

Selecting Chemical Cleansers

Factors to consider when selecting the right products for cleaning and sanitizing:

- Availablilty + quantity of container
- Level verification (necessary tools)
- Local regulation
- Special storage requirements
- Required practices and PPE

We recommend only using food safe products. Always follow chemical manufacturer's specifications for:

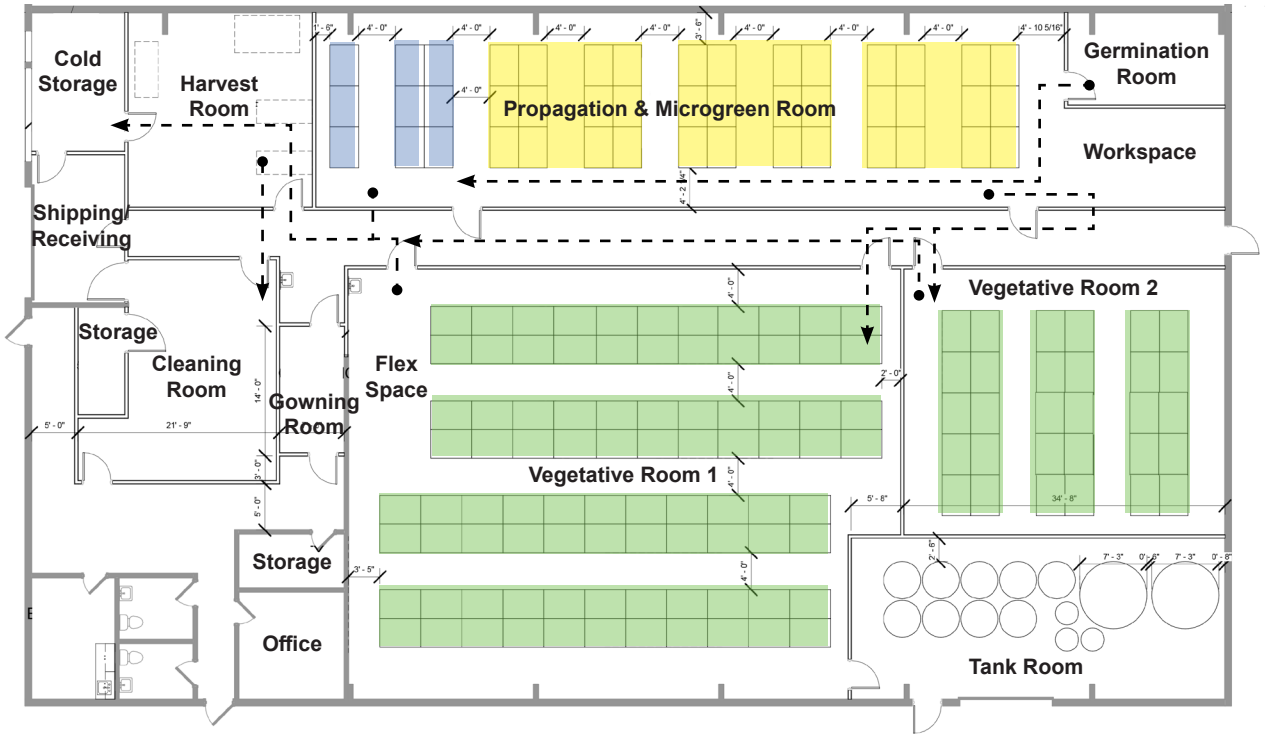
- Concentration / dilution rates
- Necessary contact time for FCSs
- Chemical level verification levels and tools (titration kits or test strips).
- Required PPE for worker safety.

Vertical Farm Planning

Farm Design

Major Design Considerations

Successful vertical farms have layouts with the best use of space to decrease both human and plant movement. While every facility will be different due to the existing building structure and municipal requirements, we have identified patterns that apply to all successful farms.



Space Utilization

Target Ratio:
80 grow : 20 process space

Operational Workflow

- Flow patterns follow a clear direction without too much overlap or crowding
- Design reduces the number of steps required by workers to acquire materials and complete tasks.
- Flow of people and materials into and out of clean room areas are designed to prevent contamination or need for additional processes.

Growing Zones

- Facility and plumbing are designed for a continuous harvest
- There is adequate separation for different crop types based on environmental, lighting, and nutritional needs.
- Design includes as much redundancy as possible to maintain good water quality and prevent whole-scale crop contamination.

Facility Considerations

- HVAC capacity and unit style
- Dehumidification method
- Electrical capacity
- Incoming water line size
- Sewer line size
- Floor type - texture and coating
- Floor drainage

Spaces within a Vertical Farm

- Germination room
- Propagation room
- Vegetative room(s)
- Flexible workspace
- Harvest room
- Cleaning room
- Clean storage
- Supply storage
- Nutrient management + tank room
- Chemical storage
- Cold storage
- Gowning area
- Bathrooms - outside of clean room area
- Office

Potential Regulation Requirements

- Fire prevention system
- Water treatment prior to disposal
- Chemical storage: quantity and containment
- CO2 use and storage
- Egress + emergency exits
- Human accessibility

Vertical Farm Planning

Farm Numbers

Calculating Estimates for Financial Planning

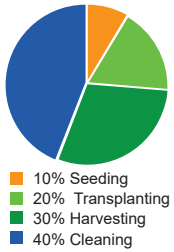
Creating an initial financial projection is a major part of vertical farm journey. To help guide this process we have compiled information from different operators to find similarities that will help guide the design and planning process. While these numbers vary based on many factors, they are meant to provide a starting point to guide the decision making process.

Top Consumables

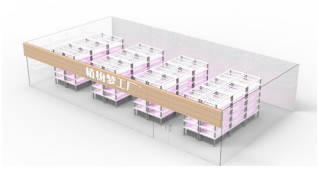
- CO2
- Nutrients
- Seeds
- Substrate: plugs and/or mats
- Personal Protective Equipment: disposable or cleaning service
- Chemical cleansers and sanitizers

Direct Labor

The number of people needed to operate a vertical farm depends on the size of facility, the level of automation, and the skill level of the operators. General estimation for non-skilled labor are:



Retail / Demonstration Facility



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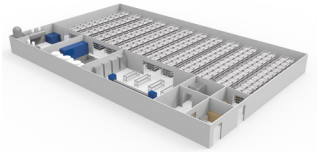
Small Scale Commercial



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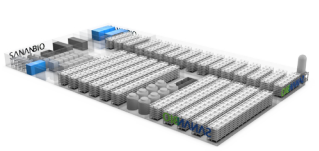
Large Scale Commercial



: x 10

Electricity

Electricity use for a facility includes the grow lights as well as major and minor equipment including HVAC. Size and location of facility will impact these numbers, here is a graphic for estimation:

Grow Lights

HVAC

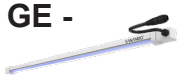
Large Support Equipment
Cold Storage / Cleaning machines

Small Support Equipment
Pumps / Nutrient dosers / RO system/ air circulation fans

Grow Light Calculation

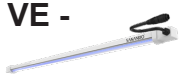
watts per light x 8 lights per layer x # of Layers x # of modules

GE -



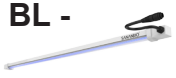
Propagation light
11.5 watt
8 per layer

VE -



Vegetative light
13.5 watt
8 per layer

BL -



Blue Light
13.5 watt
4 per layer
alternating with
4 VE lights

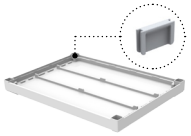
Water

Water usage varies by facility based on environmental conditions, crop selection, production method, and cleaning practices. We use the following information to estimate general water use:

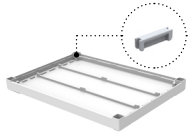
Water Usage per Crop Cycle

Fill-up x 3 = Initial Fill-up + Top off + Cleaning Cycle

System Capacity



Propagation grow bed with 25mm dam
30L / 8 gal



Vegetative grow bed with 12mm dam
15L / 4 gal

Sananbio Reservoir
175L / 50 gal

Fill-up

Grow Bed Volume x # of Layers x # of Vegetative modules + Reservoir capacity

Grow Bed Volume x # of Layers x # of Propagation modules + Reservoir capacity

Vertical Farm Planning
Equipment + Consumables

General Facility

Tools + Equipment	Consumables
Air Condition unit + MERV filters Control system or individual controllers: - temperature + humidity - fans - light timers Sealed floors Waterproof panel walls Oscillating wall fans Reverse osmosis system (Optional) Pumps + backup pumps Automatic nutrient dosing Nutrient mixing tanks Nutrient concentrate tanks CO2 Injection system, monitors,+ tanks Mobile stairs- rust proof, spring lock Stainless steel work tables (mobile) Transport carts Storage carts Pallet jack/ fork lift Hand washing stations No touch hand soap dispenser First aid + eye wash station	RO-(Optional) Carbon and Sediment HVAC filters Personal Protective Equipment (PPE) - gloves - hair nets - beard nets - water repellent jackets / full-body suits - Waterproof boots

Harvest + Post Harvest Processing

Tools + Equipment	Consumables
Mobile carts (rust proof) Cold storage unit or Commercial refrigerator Food grade harvesting totes Harvesting scissors- restaurant grade Certified, industrial scale Industrial crop mixer Non-slip floor mats Refrigerated delivery van Insulated delivery bags	Packaging: bags, clamshells Packaging sealer Packaging machine (optional) Product labels

Plant Care

Tools + Equipment	Consumables
EC meter/PH meter hand held Measuring Containers in ML Water flow timer for Radix germination Plug Popper- mechanical dislodger, peg board Germination room, chamber, or racking Seeder- vacuum or machine Seed storage refrigerator Scale for seeds Scale for raw nutrient mixing Locking, fire safe cabinets for nutrient storage: need 2 for separation	Seeds Substrate: plugs and mats Nutrients - raw salts or premix Beneficial bacteria PH adjusters: Up and Down PH calibration solution- 4,7,10 PH meter storage solution Appropriate PPE for preparing nutrient

Cleaning + Monitoring

Tools + Equipment	Consumables
Pressure sprayer Wet vacuum for cleaning module 3-bin stainless steel sink Soaking tanks for cleaning Soaking tanks for sanitizing Dishwasher Spray bottles Mop and bucket Broom and dust pan Shoe dip Cleaning baskets for caps and equipment Cleaning rolling carts Plastic pallets Drying racks for Radix accessories Scrub brushes Extension Cords Trash cans Water hose Microbial testing meter	Chemical cleaner Chemical sanitizer Chemical verification: titration or strip tests Disposable cleaning cloths Cleaning PPE - Waterproof aprons - Long waterproof gloves - Eye protection - Fume masks Microbial swabs Plastic bottles/vial Pipettes

Vertical Farm Planning
Beginner's Checklist

Next Steps

Sananbio is committed to helping our clients become succesful vertical farmers. We understand that this can be a challenging process full of many questions without answers and interconnected decisions. This page shares some commonalities we have seen in assisting clients navigate the startup journey. Though this is not always a linear process, we have tried to distill the key topics and decisions to demonstrate a path forward. Two key elements: 1. Choosing the right people to be involved in the project and bringing them in as early as possible; 2. Gaining a solid understanding of realistic timeline from permitting to construction, ordering equipment, and doing research to gain the confidence to make well-informed and timely decisions.

Key Decisions

- ☐ Operational goals: crop selection, social justice purpose, job creation, etc.
- ☐ Grow system that is best suited for desired crops
- ☐ Facility selection + planning: understanding scope of necessary work based on preliminary layout: power upgrade, roof, drainage, etc
- ☐ Understanding what will be necessary equipment + lead times for major equipment
- ☐ Key requirements for funding: restrictions / goals for grants
- ☐ Key specialists:
  - Architect
  - Electrical engineer
  - Mechanical engineer
  - Contractor
  - Electrician
  - Plumber
  - HVAC engineer
  - Water treatment

Learning & Planning

- ☐ Key team members:
  - Facility manager
  - Head grower
  - Food safety coordinator
- ☐ Understand general process flow for operation
- ☐ Understand federal and local food production regulation + requirements
- ☐ Verify local codes for permiting, fire suppression system, egress, and zoning
- ☐ Requirements for water treatment prior to disposal or for reuse
- ☐ Obtain full analysis of source water.
- ☐ Associated equipment and technology:
  - Nutrient management
  - Environmental control
  - Data analytics
  - Airflow
  - Water treatment
  - Seeding, harvesting, and packaging equipment

Detailed Design

- ☐ Finalize grow system quantities
- ☐ Understand system specifics:
  - Plumbing
  - HVAC
  - Nutrient management
- ☐ Understand fire prevention and chemical storage
- ☐ Understand municipality requirements and timeline
- ☐ Apply for necessary permits + license:
  - Construction
  - Food sales
  - Food processing
- ☐ Design in failsafe options where possible:
  - Water resistant floors and wall bases
  - Extra pumps
  - Water valve shut offs
  - Pump and flood alarms
  - Control system notification systems

Construction + Installation

- ☐ Understand construction timeline and major milestones
- ☐ Necessary inspections:
- ☐ Preinstallation electrical work
- ☐ Installation of grow equipment
- ☐ Plumbing installation and connections
- ☐ Whole system commissioning:
  - grow system
  - electrical
  - environmental control
  - plumbing
  - nutrient management

Beginning Operation

- ☐ Create facility SOPs
- ☐ Hire and train first round of operators
- ☐ Create workflow and production schedule
- ☐ Full clean of all rooms and equipment
- ☐ Begin production: ramp up process to first harvest takes 7 weeks for mature crops. First harvest is rarely considered successful.
- ☐ Dial in growing process: first 3 batches are a key testing time to work through process, people, and dial in nutrient, varieties, grow times, and basic environment challenges. This can take 4-6 months.
- ☐ Harvest and go to market