

# Microfarm

**Objective:** A closed-loop, permanent homestead infrastructure integrating a decentralized hydroponic system, automated robotic nutrient processing, passive thermal mass, and a climate-controlled winter solar trap.

## PART 1: GREENHOUSE

*The physical shell protecting the system and harnessing solar energy.*

### 1.1 Materials & Structure

- **Glazing:** 8mm Clear Twin-Wall Polycarbonate Panels. Fluted air channels provide thermal insulation (R-value ~1.6) while transmitting 80%+ of full-spectrum PAR light. Impact-resistant and easy to cut/screw.
- **The Frame:** Pressure-treated 2x4 and 4x4 lumber.
- **The Roof Pitch:** Minimum 8/12 pitch (33+ degrees). The steep angle, combined with the slick polycarbonate and escaping internal ambient heat, causes winter snowpacks to automatically slide off before the weight crushes the frame.

### 1.2 Foundation & Frost Protection (The Decoupled Earth)

Do not build directly on frozen grass; the earth will suck the heat out.

1. Dig a 12-inch deep trench around the exact perimeter.
2. Bury 2-inch XPS Rigid Foam Insulation board vertically in the trench.
3. Lay the 4x4 wooden base on top. *Result:* The earth inside the greenhouse is thermally decoupled from the frozen New England ground outside.

### 1.3 Interior Layout (The Heat Battery)

- **Perimeter Zone (Soil Beds):** 2-foot deep raised beds along the North, East, and West interior walls. Filled with compost/soil for growing root vegetables and winter squash. This massive volume of wet soil absorbs solar heat during the day and radiates it all night, preventing flash-freezes.
- **Center Zone (Hydro Stack):** Vertical LECA towers sit in the center aisle, protecting them from cold exterior walls and allowing 360-degree harvesting.
- **Reservoir Burial:** The main hydroponic reservoir is buried *inside* the center raised soil bed. The soil acts as an insulating jacket, preventing the root-zone water from freezing.

## PART 2: HYDROPONICS

*The high-speed, sterile plant production engine.*

### 2.1 System Flow Logic

To prevent root rot and fungus gnats in high humidity, raw organics are never placed in the plant roots. The system is decoupled: [Automated Bioreactor] --(Filtered Liquid)--> [Main Reservoir] --(Pump)--> [Vertical Columns] --(Gravity Drain)--> [Main Reservoir]

### 2.2 The Grow Medium

- **Mix:** 70% LECA / 30% Pumice. 100% inert.
- **Why:** LECA provides extreme aeration and a dry top-layer that suppresses fungus gnats. Pumice is dense, anchoring large root systems against outdoor winds without floating away.

### 2.3 The Main Reservoir & Circulation

- **Additives:** Clean water receives the filtered compost tea from the Bioreactor. **CalMag** is added directly to this reservoir (LECA/Pumice holds zero calcium/magnesium, making this liquid supplement critical).
- **Delivery:** A submersible pump runs on a timer (constant slow drip or ebb/flow bursts), pushing water through the towers before gravity-draining back.

## PART 3: BIOREACTOR

*The offline nutrient processing factory. Turns dry raw organics into liquid hydroponic feed.*

### 3.1 The "Brain" & Sensor Suite

- **Microcontroller:** ESP32 (WiFi/Bluetooth enabled for web dashboard).
- **Sensors:** \* Industrial EC/TDS Sensor (Measures total dissolved solids to track digestion progress).
  - Industrial pH Sensor (Flags errors if brew drops below 5.5).
  - Non-Contact Liquid Level Sensors (x2, High and Low).

### 3.2 The Robotics & Plumbing

- **Dispensing:** 3x NEMA 17 Stepper Motors driving 3D-printed Auger/Archimedes screws.
- **Hoppers:** Sealed, airtight hoppers holding:
  1. Growers Secret 16-0-0 Nitrogen
  2. Roots Organics Seabird Guano

3. Growers Secret Seaweed Powder. (*Note: Mycorrhizal inoculant is excluded as it requires live roots*).

- **Pumps/Valves:**

- Intake Solenoid Valve (Fresh water).
- Heavy-Duty Air Pump (Aeration).
- Peristaltic Transfer Pump (Transfers thick liquid without clogging).
- Motorized Ball Valve (Waste drain for thick sludge).

### 3.3 The 6-Phase Automation Loop

1. **Flush & Fill:** Solenoid opens, filling bucket with fresh water. Air pump turns on. (Liquid Humic/Fulvic Acid acts as carbon food).
2. **Recipe Dispense:** ESP32 triggers Stepper motors to drop exact grams of Nitrogen, Guano, and Seaweed based on the weekly growth phase.
3. **Brew & Monitor (48-Hour):** Violent aeration breeds aerobic bacteria. EC levels start low and plateau when digestion is complete.
4. **Self-Correction:** If EC plateau is too low, steppers drop a booster dose and brew for 12 more hours.
5. **Filtered Transfer:** Air pump turns off for 2 hours (sludge settles to bottom). Peristaltic pump (intake set 3" high) pulls clear liquid through a 400-micron inline filter into the Main Reservoir.
6. **Self-Flushing Waste Cycle:** Motorized Ball Valve opens at the bottom. Intake Solenoid opens simultaneously. Fresh water power-washes the heavy sludge out to a yard waste/compost pipe. System resets.

## PART 4: ELECTRICAL SCHEMA

*The Sonoff S31 / Tasmota smart-plug network balancing the winter micro-climate.*

### 4.1 Sensor Placement

- **Sensor 1 (Canopy):** Air Temp & Relative Humidity.
- **Sensor 2 (Reservoir):** Root Zone Water Temp.
- **Sensor 3 (Outdoors):** Rain Catchment Water Temp.

## 4.2 The "Muscles" (Smart Plug Rules)

- **Plug 1: Grow Lights (Winter Sun/Passive Heat)** \* *Rule:* ON from 6:00 AM to 8:00 PM.
  - *Override:* ON if Night Temp drops below 35°F (uses radiant LED heat to save crops).
- **Plug 2: Space Heater (Pulse Heating)** \* *Rule:* ON if Air Temp < 38°F. OFF when Air Temp > 45°F. (Just keeping biological water from freezing).
- **Plug 3: Exhaust Fan (Humidity Control)** \* *Rule:* ON if Humidity > 75%. OFF when < 60%.
  - *Conditional Lockout:* DO NOT run if Air Temp < 40°F (prevents exhausting critical heat).
- **Plug 4: Outdoor Rain Barrel De-Icer**
  - *Rule:* ON if Outdoor Water < 34°F. OFF when > 40°F.
- **Plug 5: Catchment Transfer Pump**
  - *Rule:* Activates when Main Indoor Reservoir level drops, topping it up with melted snow.

## 4.3 Humidity Defense Strategy

In winter, you cannot always exhaust humid air without freezing the plants.

1. **Always-On Airflow:** 24/7 internal oscillating clip-fans prevent condensation from settling on leaves.
2. **Cover the Reservoir:** A tight lid stops massive evaporation.
3. **Warm Roots:** Keeping the root-zone water warmer than the air (via ambient soil insulation or an aquarium heater) reduces plant transpiration and bolsters cold-shock survival.

## PART 5: WATER CATCHMENT

- **Gutters & Protection:** Aluminum gutters mounted to the A-frame roof edge. Covered entirely by **Micro-Mesh Gutter Guards** and a **Downspout Strainer** to prevent pine needles and autumn leaves from rotting in the water supply.
- **The Flow:** Roof -> Gutters -> 50-Gallon Opaque Outdoor Barrel (De-iced by Plug 4) -> Transfer Pump (Plug 5) -> Indoor Main Reservoir.

## PART 6: MAINTENANCE

- **Daily/Weekly:** Verify Main Reservoir water levels. Check for clean/earthy smell (sulfur/sewage indicates anaerobic bacteria or clogged filters).
- **Monthly:** Fill Bioreactor dry hoppers. Check CalMag levels.
- **Seasonal (Exterior):** Clean polycarbonate panels using a telescoping ultra-soft microfiber RV brush, Dawn dish soap, and warm water on an overcast day. *Never use stiff brooms or bleach (destroys UV coating).*
- **Seasonal (Interior):** Scrub algae biofilm with a 10% white vinegar / 90% water solution. Empty main reservoir to flush accumulated salts. (No medium tear-down required due to 100% inert LECA).

# Benefit & Revenue

**Entity:** Public Benefit Limited Liability Company or Public Benefit Corporation **Sector:** Controlled Environment Agriculture (CEA), Ag-Tech Intellectual Property (IP)

## 1. Executive Summary

This document outlines the dual-revenue business model for a decentralized, automated homestead microfarm. Operating as a benefit entity, the company generates revenue through two distinct pipelines:

- **Physical Production:** Direct-to-Consumer (DTC) and B2B sales of high-yield hydroponic crops, heavily optimized by third-party logistics.
- **Intellectual Property (IP) Licensing:** Commercializing the "Automated Bioreactor & Greenhouse" and seed patent technology to third-party growers using a novel, consumer-price-informed revenue-sharing model to deter price gouging.

This architecture leverages the "doctrine of internal affairs" to legally shield management from traditional shareholder lawsuits, ensuring the company can ruthlessly pursue market efficiency while legally enforcing its public benefit mandate.

## 2. Corporate Structure & The Legal Shield

The foundation of this revenue model relies on the benefit entity charter. It provides a dual-mandate shield that allows management to prioritize local food security and affordable market pricing alongside financial returns.

4. **The Production Quota Shield:** If a premium buyer attempts to purchase 100% of the farm's yield, the benefit entity charter legally obligates management to refuse the sale of the predetermined public benefit tranche (e.g., 11.8%), ensuring community needs are always met first.
5. **The Triple Bottom Line:** The company utilizes openLCA for life-cycle assessments and adheres to the Global Reporting Initiative (GRI) and International Financial Reporting Standards (IFRS) to transparently measure its duty of obedience to the public benefit.

## 3. Revenue Stream A: Physical Production & Yield Routing

The flagship microfarm in Fairfield, CT acts as the primary physical revenue generator. To balance high-profit commercial sales with community food security, the physical yield is strictly bifurcated at the moment of harvest.

## The 88.2% Commercial Route (The For-Profit Stack)

- **Logistics Hub:** 88.2% of the yield is picked, packed, and routed to **ShipMonk** for specialized Food & Beverage fulfillment.
- **DTC/B2B Fulfillment:** ShipMonk utilizes temperature-controlled storage and its Virtual Carrier Network (VCN) to route fresh produce to direct consumers and retail partners at optimal speeds.
- **Inventory Integrity:** Strict Lot Tracking enforces First-In, First-Out (FIFO) rotation to minimize spoilage and protect profit margins.

## The 11.8% Public Benefit Route (The Safety Net)

- **API Routing:** Based on the USA food insecurity percentage from Feeding America's Map of the Meal Gap (11.8%), this exact percentage of the crop is routed automatically via the **MealConnect® API**.
- **Zero-Waste Protocol:** Local Fairfield pantries receive instant push notifications to pick up the fresh produce.
- **Food Rescue (Carbon Asset Generation):** Any expiring commercial inventory at the ShipMonk hub is rescued by Feeding America. By diverting this from landfills, the benefit entity generates measurable Carbon Offset Credits, creating a secondary, environmentally-backed financial asset.

## 4. Revenue Stream B: IP Licensing & Anti-Gouging

As the microfarm's automated bioreactor, decoupled plumbing, ESP32 code, and seed patents prove highly efficient, the public benefit entity may license this technology (IP) to regional farms, distributors, and commercial growers.

Instead of standard fixed-rate royalties, the entity employs a **dynamic, consumer-price-informed revenue-sharing agreement**— a "vig against price gouging."

### Mathematical Frameworks for the Pricing Function

To execute this model, the licensing agreement defines the exact threshold at which royalties trigger and how they escalate based on the final retail price per pound. The "zero-royalty floor" is set above a reasonable agricultural production cost plus a modest margin (e.g., covering seeds, water, electricity, and distribution), giving the licensee total freedom within fair-market bounds.

The royalty structures can be customized using several mathematical forms to suit different crops and markets:

## A. Progressive / Stepped Approach

A tiered system where the revenue share percentage jumps at specific retail price thresholds.

- **Example (CEA Greens / Heirloom Tomatoes):**
  - **0% Royalty for \$0.00 - \$3.00/lb (The Accessible Tier):** Allows the licensee to keep 100% of revenue if they prioritize high-volume, affordable community distribution.
  - **5% Royalty for \$3.01 - \$6.00/lb (The Standard Commercial Tier):** A standard software/IP royalty cut for standard retail pricing.
  - **30% Royalty for \$6.01 - \$12.00/lb (The Premium / Restaurant Tier):** If the grower is selling to high-end boutique chefs, the IP holder takes a larger cut of the luxury margin.
  - **90% - 100% Royalty for \$12.01+/lb (The Anti-Gouging Penalty):** Artificially induced scarcity and hyper-luxury markups are mathematically neutralized, as the IP holder captures all excess revenue.

## B. Continuous Curve Functions

Instead of hard steps, these formulas calculate the royalty on a sliding scale, allowing for natural agricultural market fluctuations.

- **Logarithmic:** Royalty =  $\log(\text{price}) \times \text{multiplier}$ . Creates a slow royalty increase, forgiving mild price hikes due to inflation or seasonal energy costs.
- **Exponential:** The royalty rate increases exponentially as the price rises, acting as a hard, fast brake against sudden price gouging during local food shortages or supply chain disruptions.
- **Sigmoid Curve:** Allows for a gentle, forgiving variance at lower/average price points (accommodating normal grocery store markups), followed by a sharp, vertical ramp-up only when pricing becomes definitively unreasonable.

## C. Market-Benchmarked (Dynamic Data Integration)

This framework connects the contract directly to real-world agricultural economic data, adjusting automatically without requiring contract renegotiations.

- **Base Rate Trigger:** The royalty threshold is pegged dynamically to the USDA National Retail Report (or regional NielsenIQ grocery data) for that specific crop.
- **Penalty Rates:** Triggered instantly if the licensee prices their crop at 2x or 3x the current regional average.

- **Bonus Rates (Rebates):** Negative rates (IP subsidies) offered to licensees who manage to use the automated technology to price their crops *below* the regional average, actively rewarding hyper-efficiency and community accessibility.

## Incentive Dynamics

- **For the Licensee:** Margin extraction through arbitrary price hikes becomes mathematically impossible. To maximize absolute profit, the licensee is forced into a strategic pivot toward operational efficiency, high-volume production, and low consumer costs.
- **For the public benefit entity (IP Holder):** It naturally filters partners, attracting highly efficient operators while extracting maximum value from any corporation attempting to monopolize the technology for luxury pricing.

## 5. Software & Partners

To efficiently manage this bifurcated revenue and complex licensing structure with a lean management team, the benefit entity relies on a highly integrated tech stack:

- **Enterprise Resource Planning (ERP):** **Odoo** is utilized for back-office accounting, triple-bottom-line ledger management, and internal warehouse tracking.
- **3PL Distribution:** **ShipMonk** handles physical fulfillment, DTC routing, and reverse logistics.
- **Data Integration:** **MealConnect API** manages the algorithmic dispatch of the 11.8% public benefit yield.
- **Data Collection (Licensing Audits):** Automated API scrapers monitor major grocery and retail databases (e.g., NielsenIQ, regional grocery aggregators) to verify the final consumer pricing of licensees, automatically calculating the dynamic royalty rates.

## 6. Summary of Outcomes

By weaving together precision hydroponics, automated charity routing, and anti-exploitative IP licensing, this benefit entity model achieves three distinct goals:

1. It generates high-margin cash flow through optimized DTC/B2B agriculture.
2. It guarantees the immediate, uncompromised feeding of the community.
3. It weaponizes contract law to scale proprietary CEA technology globally, forcing the broader agricultural market toward hyper-efficiency and consumer affordability.