

# GREENGUARD



*- GUARDING A GREENER FUTURE -*

Innovation Plan

Palak Jumaní

South Forsyth High School

585 Peachtree Pkwy, Cumming, GA 30041

April 25, 2025

# Table of Contents

<b>I</b>	<b>Executive Summary .....</b>	<b>1</b>
<b>II</b>	<b>Problem .....</b>	<b>2</b>
<b>III</b>	<b>Customer Segment .....</b>	<b>3</b>
<b>IV</b>	<b>Unique Value Proposition .....</b>	<b>4</b>
<b>V</b>	<b>Solution .....</b>	<b>6</b>
<b>VI</b>	<b>Conclusion .....</b>	<b>9</b>
<b>VII</b>	<b>Appendix .....</b>	<b>10</b>

# I. Executive Summary



## Company Overview

GreenGuard's mission is to guard against unnecessary carbon emissions and food waste to ensure a greener future for the planet. GreenGuard's Smart Sensor seeks to prevent food spoilage before it even occurs. By using the aid of chemical, visual, and spatial input; the Smart Sensor provides real-time access to scientific conclusions about the freshness of foods inside a user's fridge.



## Problems

### Food waste and its environmental effects

\$50 of food wasted weekly (Each household) → \$2500 wasted per year (Each household) → 6% of global carbon emissions

### Lack of awareness of food freshness

Food doesn't have freshness labels → People can't discern rotten from edible → A lot of food is wasted



## Target Market

Families	Individuals	Seniors
Middle/upper class families in states with a high suburban population. They may have busy lifestyles and look for products that streamline daily tasks.	Adults in their 20s-40's who are budget-conscious and under time-constraints. We will focus on areas with a high concentration of single-person housing.	This group is inclined to maintain a healthy diet and be more mindful of expiration dates, so, we will target areas with a higher number of retirees.



## Unique Value Proposition

GreenGuard's Smart Sensor is an **INTEGRATED** solution to the crisis of food waste that allows users to make smarter, more **SUSTAINABLE** choices. By preventing food waste, GreenGuard users can **SAVE MONEY** and help **PROTECT THE ENVIRONMENT**.



## Solution

### High-Res Camera:

Provides 360° visual input to aid in the analysis process.

### Chemical Sensors:

Provides initial chemical input

### Infrared Sensors:

Pinpoints direction of chemical input to narrow down the origin of chemical compounds detected and improve accuracy.

### Battery Chamber:

Houses the power supply and ensures uninterrupted operation of the device.

### Chemical analyzer:

The **core system** for identifying the detected chemicals. Provides detailed insights into spoilage or freshness.

GreenGuard  
- GUARDING A GREENER FUTURE -

Cucumber  
Tomatoes

See chemical analytics  
See temperature analytics  
See visual analytics

### Wi-Fi and Bluetooth

let users connect to the GreenGuard app to check how long their food will continue to be edible. The app also suggests recipes using food that's about to expire.

GreenGuard  
- GUARDING A GREENER FUTURE -

Find Recipes

Recipes with your ingredients

Mediterranean Bowl  
Chicken 65  
Stir-fry Noodles  
Brunch Egg-Salad

## Sales Projections

	Year 1	Year 2	Year 3
Units Sold	16,800	45,000	66,600
Sales*	\$3,360,000	\$9,000,000	\$13,320,000
Profit	\$1,579,000	\$4,650,000	\$6,190,000

\*based on a retail price of \$200 per unit

## Investment Opportunity

GreenGuard is seeking a **\$1 million investment in exchange for 15% ownership stake**. The investment will be used to cover costs of scaling up production, investing in R&D with partnerships with LG and Samsung, and enhancing GreenGuard's marketing efforts to drive increased sales and brand awareness.

# II. Problem

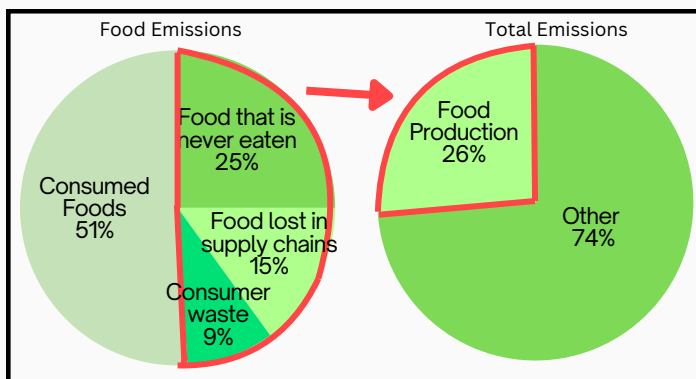
**Greenguard's Smart Sensor solves the following problems:**

1. Food waste/Environmental effects of food waste
2. Lack of personal awareness of food freshness
3. Inability to understand 'use by' and 'best by' labels, (Difficulty tracking expiration dates)

## **1. Food Waste & Environmental effects:**

According to a study conducted by OnePoll in 2019, the average American tosses about \$50 worth of spoiled food from their refrigerator weekly, or about \$2,500 every year. This number arises from overconsumption of groceries which allows food to go bad before it can be used. Food waste has many environmental consequences. When throwing out food, people also waste the resources that were used to cultivate and manufacture the food. Americans collectively throw away enough edible food to feed **25 million Americans** each year, just through overconsumption and lack of awareness.

According to the University of Michigan, food accounts for 10-30% of a household's carbon footprint. A study done by the Intergovernmental Panel on Climate Change shows that food production accounts for around one-quarter (26%) of greenhouse gas emissions from food. Food waste is corresponded to 6% of total greenhouse gas emissions.



## **2. Lack of personal awareness of food freshness:**

Fresh produce, such as fruits and vegetables don't usually come with best by labels. Many consumers don't know exactly how long fresh food will last in their refrigerator. People will sometimes assume that a fruit or vegetable has gone bad after having been in the fridge for an extra few days, when in reality, the food is still edible. According to an interview on NPR with Jonathan Bloom- a food waste activist and journalist- "the prevailing attitude tends to be when in doubt, throw it out,". Because people don't have any way of discerning rotten from edible, a lot of food gets thrown away unnecessarily.

## **3. Inability to track expiration dates:**

A survey conducted by Respect Food reported that 63% of people don't know the difference between "use by" and "best before" dates. Because of this, a lot of food is thrown out immaturely, with people not willing to take risks with their food intake, almost 20% of food thrown away is just due to it being "ugly" or "expired", when the food is still chemically and physically edible. Many foods can be eaten past their use by date, which is reflected in our bodies' abilities to recognize signs of decay. Instead of trusting labels, it is more efficient to use better and more accurate methods of decay detection, which will help prevent unnecessary food waste.

# III. Customer Segments

Because the need for fresh, quality food will never fade, GreenGuard has a large market potential. The global food preservation/ packaging market was valued at 335.9 billion USD in 2022, and is projected to grow to a value of 592.8 billion USD by 2033. The emphasis that has been placed on food freshness by global consumers is increasingly evident. As a result of this growth, GreenGuard will be well positioned to tap into this market. While many consumers look into investing in better storing methods, these efforts can be enhanced by GreenGuard’s smart sensor as it will allow consumers to see the freshness of their food at every step of the food cycle.

	Primary	Secondary	Tertiary
	Families	Individuals	Seniors/ Empty-Nesters
Demographics	<ul style="list-style-type: none"><li>Adults over 26 years old**, with a significant portion in their 30s-50s.</li><li>Parents with children and dual-income or multiple-member households</li><li>Middle to upper-middle class, with disposable income to invest in household innovations.</li></ul> <p>** The avg age that people start families (according to census data)</p>	<ul style="list-style-type: none"><li>Adults aged 20-40 years, either early in their careers or living alone in urban or suburban areas.</li><li>Lower to middle-income individuals with smaller disposable incomes, (and thus want to save the money they are wasting by throwing out food).</li><li>Young professionals, single adults, students, or people living in small apartments.</li></ul>	<ul style="list-style-type: none"><li>Adults aged 50+, Smaller households, often with just two people (married couples, elderly parents).</li><li>Upper-middle-class or retirees with fixed income but a focus on home investments.</li><li>Retired or semi-retired individuals who may spend more time at home, taking care of the household.</li></ul>
Geographics	<ul style="list-style-type: none"><li>Suburban areas near large retailers such as HomeDepot, Lowe’s, and Target. (Easily accessible to this segment).</li><li>Areas with larger homes and multiple occupants, larger kitchens, and the likelihood of needing a stocked fridge.</li><li>Focus on states with a high concentration of suburban living, such as California, Texas, Georgia, etc</li></ul>	<ul style="list-style-type: none"><li>Mostly urban areas where individuals live in smaller apartments or homes with smaller fridges.</li><li>Regions with access to single-person housing units, such as in large cities like New York, Chicago, or Boston.</li></ul>	<ul style="list-style-type: none"><li>Suburban or rural areas, where older adults may live in larger homes they’ve owned for years.</li><li>Focus on areas with a higher number of retirees (e.g., Florida, Arizona, or retirement communities).</li></ul>
Psychographics	<ul style="list-style-type: none"><li>Have busy lifestyles, balancing work and family</li><li>Families who value convenience, organization, and minimizing food waste.</li><li>Health-conscious, environmentally aware, budget-conscious</li><li>Likely to spend on products that provide long-term savings and convenience.</li></ul>	<ul style="list-style-type: none"><li>Individuals who are budget-conscious, possibly meal prepping or shopping less frequently due to time constraints.</li><li>Likely to be tech-savvy and interested in smaller-scale, practical smart home solutions.</li><li>Not likely to spend large sums on luxury kitchen tech but interested in affordable versions</li></ul>	<ul style="list-style-type: none"><li>Health-conscious</li><li>Inclined to maintain a healthy, balanced diet and may be more mindful of expiration dates and food safety.</li><li>Want to save money by preventing food spoilage, maintaining food freshness, and simplifying household routines.</li><li>Tend to invest in durable home appliances and gadgets</li></ul>



# IV. Unique Value Proposition



## INTEGRATED SOLUTION TO FOOD WASTE

GreenGuard's Smart Sensor is a real-time, **INTEGRATED** solution to the food waste crisis that identifies foods that have started to spoil in refrigerators and prevents households from throwing out food due to spoilage, decreasing their overconsumption as well. This product will ensure food safety by letting consumers know which foods are still edible, and which ones should be thrown out. Overall, this innovation can help prevent food waste on a large scale, in the household and globally.



## COST-EFFECTIVE

The average American household will toss \$2,500 of spoiled food. Using GreenGuard's Smart Sensor, households will be saving \$2,500 yearly, money that can go into other expenses and lifestyle choices. GreenGuard reminds users when their food has started to get old and gives users a means to prioritize what foods should be consumed first so they can throw out less spoiled food and **SAVE MONEY** on groceries.



## CONVENIENT SUSTAINABILITY

GreenGuard makes it **CONVENIENT** for users to monitor and reduce food waste due to its user interface. The app will allow users to identify what foods are in their fridge, and which foods need to be thrown out and re-bought. It identifies which items are nearing spoilage, helping users plan meals, avoid unnecessary grocery trips, and save money. Designed for busy households, GreenGuard empowers consumers to make smarter, more sustainable choices, giving them peace of mind and control over their food storage.



## ENVIRONMENT FRIENDLY

By preventing unnecessary food waste, GreenGuard can reduce carbon emissions correlated to food waste. The Environmental Protection Agency estimates that each year, U.S. food loss and waste accounts for 170 million metric tons of carbon dioxide (excluding landfill emissions) – the equivalent of the annual CO2 emissions of 42 coal-fired power plants. This estimate does not include the methane emissions from food waste rotting in landfills. EPA data shows that food waste is the single most common material landfilled and incinerated in the U.S., comprising 24 percent of landfilled solid waste.

GreenGuard's larger goal is to **PROTECT THE ENVIRONMENT** by making it possible to help slow effects such as global warming and prevent the need for more landfills in the future.

Users that specifically look to be more environmentally conscious will be drawn to GreenGuard due to its larger mission.

## Key Benefits:

### Real-Time Monitoring:

GreenGuard tracks environmental conditions within the refrigerator, ensuring optimal storage and prolonging food freshness.

### Spoilage Alerts:

The system notifies users when food items approach spoilage, prompting timely consumption and reducing waste.

### User-Friendly Interface:

The accompanying mobile app offers intuitive access to data, enabling users to make informed decisions about their food storage and consumption. Freshness scales make it easy for users to gauge how edible certain products are.

### Integrated Meal Planner:

The meal planner feature on the mobile app recommends recipes that use ingredients nearing expiration, making it easy for users to incorporate such items into their meals before they spoil.



Now, more than ever before, it has become convenient for users to pull out their phones and ensure the quality of their food.

The GreenGuard Smart Sensor is a cutting-edge accessory designed to integrate seamlessly into consumers' refrigerators, continuously monitoring the freshness of stored food items.

Leveraging advanced sensor technology, the Smart Sensor provides real-time data on spoilage indicators, accessible through a user-friendly mobile application.

With increasing consumer awareness of environmental issues and a growing demand for sustainable living solutions, GreenGuard is poised to align its focus on reducing food waste with global sustainability efforts.

The Smart Sensor offers a tangible benefit to households by decreasing grocery expenses while also insuring food quality and helping the environment.

# V. Solution

GreenGuard’s Smart Sensor is an accessory that can be attached to the inside of your fridge. It will use chemical, visual, and spatial sensors to sense chemical/enzyme changes in food. **The main intention behind the creation of this product is to detect food waste before it occurs**, ensuring that households can do everything in their power to prevent food from going bad or being thrown out.



## I. Key Features

Feature	How it works	What this means
Chemical Detection and Analysis	Combines MQ sensors (e.g., MQ-3 for alcohol, ethanol, and smoke detection) to identify specific chemicals emitted by spoiled food. Processes sensor data for precision.	GreenGuard can detect specific gases released by food spoilage, such as ethanol from fermenting fruits or smoke-related changes, enhancing its food monitoring.
Temperature and Humidity Monitoring	Temperature sensors (e.g., thermistors) and humidity sensors (e.g., capacitive or resistive) continuously measure environmental conditions. Threshold-based alerts trigger if levels deviate from optimal ranges for food preservation.	Ensures food stays in ideal storage conditions. Proactively prevents spoilage caused by improper fridge conditions, saving money and improving efficiency.
Visual Recognition	A camera, paired with image processing algorithms (e.g., convolutional neural networks), detects visual changes in food, such as mold growth, texture shifts, or discoloration. Light levels and contrast adjustments enhance accuracy.	Provides a secondary layer of detection. Enhances GreenGuard's reliability by identifying spoilage signs that gas sensors alone might miss.
Spatial Awareness	Infrared sensors map the position of food items and correlate detected gases with spatial data. Algorithms track food movement and calculate distances to locate the source of emissions.	Pinpoints the spoiled item without user effort. Improves convenience and usability by simplifying fridge organization and reducing guesswork. Allows for recognition of where exactly in the fridge the chemical change was detected in order to recognize which foods are rotting.
Smart Notifications	Data is transmitted via Wi-Fi or Bluetooth to a connected smartphone or smart home device. Notifications include detailed spoilage data, such as the food type and estimated time of spoilage. Data is also visible on a user interface.	Ensures users are always informed in real time, preventing missed spoilage warnings. Data is also visible on a connected app, allowing users to view the history of their food spoilage and current indicators of food spoilage in their fridge.



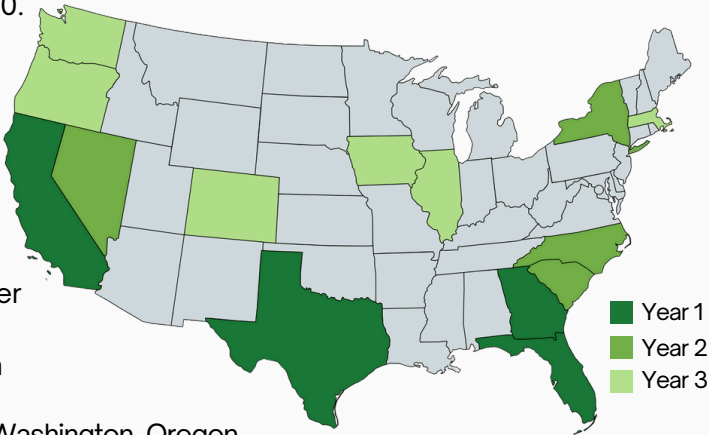
Analysis software integration	Input from chemical, spatial, and visual sensors is processed using a Random Forest algorithm. The algorithm takes details such as VOC concentrations, food position, visual spoilage indicators (like color shifts or mold patterns), and environmental conditions (e.g., temperature and humidity); and analyzes these inputs together to estimate the spoilage stage or ripeness level of each food item.	Offers precise insights about food freshness by combining multiple data points. For example, it can differentiate between early ripeness, peak freshness, and late spoilage, helping users make informed decisions about consumption or storage. This reduces waste and ensures accurate detection.
Energy-Efficient Design	GreenGuard utilizes low-power microcontrollers such as the ESP32 or STM32 series, which feature deep-sleep modes and energy-efficient cores. These microcontrollers handle sensor data acquisition and preliminary processing while conserving battery life.	Prolongs the device's operational life on minimal power, making it more practical for everyday use and environmentally sustainable.

## II. Development

- **MVP Phase:** The MVP, or minimal viable product, serves as a prototype for initial testing. The MVP’s web application backend is coded in python. Development of the MVP takes 3 weeks with 1 developer because our MVP was created with a limited range of foods to differentiate and analyze.
- **Extensive VOC’s research:** After the initial MVP, the Smart Sensor requires extensive research on volatile chemical compounds released by a wide range of food items. Trials will be conducted with various foods, and their chemical compounds and threshold levels will be recorded before being added to a comprehensive database with information for all types of food. This new database will be tested to analyze performance and find flaws/successes.
- **Initial Release:** Upon completion of initial research and production, the Smart Sensor will be released to beta testers so GreenGuard can monitor success in actual households. Release to the general public will follow a few months after beta testing.
- **Expansion:** After the first 6 months of release, GreenGuard will expand into 240 stores across 4 states at retailers like Walmart, Home Depot, and BestBuy. GreenGuard will partner with Samsung and LG to develop device variants optimized for Samsung's Family Hub refrigerators and LG's InstaView models. The product line will include premium, mid-range, and compact versions. These models will maintain the functionality of GreenGuard while fitting various refrigerator designs and sizes, while also meeting demand for households with various budget ranges.

## III. Pricing and Product Placement

- The retail price of the GreenGuard Smart sensor is \$200.
- Initially, GreenGuard will focus on strategically entering the market by being available in 4 key states, Georgia, Texas, California, and Florida. We will be available at partnering retailers like HomeDepot, Walmart, and BestBuy.
- During the first 6 months, we will be in 100 stores, expanding into 100 more in the second half of the year.
- In the second year, we aim to expand into secondary-tier states like North Carolina, South Carolina, New York, Nevada, and New Jersey; with availability in 50 stores in each state.
- During the third year, we will expand into another 5 states: Washington, Oregon, Colorado, Massachusetts, and Illinois; with availability in 30 stores in each state.



# VI. Conclusion

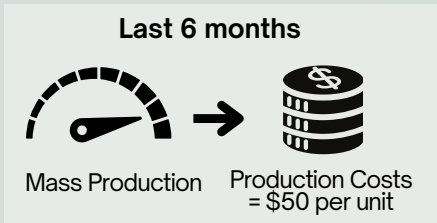
## Overview:

To solve the problems of food waste, unawareness of food freshness, and inability to track expiration, we created GreenGuard, a fridge accessory that uses chemical, visual, and spatial sensors to sense chemical/enzyme changes in food. The main intention behind the creation of this product is to **detect food waste before it occurs**, giving users an easy and reliable way to manage their food while saving money and reducing their negative environmental impact. GreenGuard stands out because it combines cutting-edge technology with practicality, empowering households to make smarter choices and contribute to a more sustainable future.

Problem	Solution	Significance
One-fourth of food that is cultivated globally is wasted. This corresponds to 6% of world greenhouse gas emissions.	GreenGuard will prevent over-purchasing due to users implementing better food management.	We are aiming for 10% market penetration by 2030. This would be 10 million American households. A clientele base of this size would reduce America’s carbon footprint by 9.45 million metric tons CO <sub>2</sub> e annually.
Expiration dates are often misunderstood. Surveys show that 63% of people don’t know the difference between “use by” and “best by” dates. This confusion leads to premature disposal of perfectly good food or, conversely the consumption of expired items.	The SmartSensor can recognize chemical changes in the composition of different foods in the fridge. Visual sensors will use image processing software that can identify which foods are rotting.	GreenGuard can use multiple indicators that will help the SmartSensor reach a conclusion about what stage of the freshness cycle that food is in (fresh, ripened, rotting, rotten). These features eliminate the guesswork associated with food expiration, leading to better understanding of how fast produce expires and less food thrown away.

## Product Launch:

GreenGuard will initially be available at retailers - Walmart, Home Depot, and BestBuy - across California, Texas, Georgia, and Florida. During this initial stage, which will last 6 months, GreenGuard’s production costs will be \$80 per unit (due to being in a low production stage). After the first 6 months, we will transition into mass production, which brings production costs down to \$50 per unit.



## Product Value:

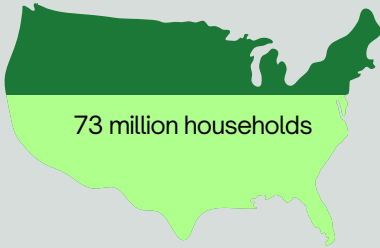
The average American household wastes \$2500 worth of spoiled food every year; that’s \$208 every month. The GreenGuard Smart Sensor can help prevent food waste and will thus pay for itself within a month, making it an investment into future savings.

## Marketing:

GreenGuard's marketing strategy will employ a comprehensive strategy, including targeted digital campaigns on social media platforms such as Instagram and Facebook; strategic partnerships with Samsung; participating in environmental conservation events like ICWMRE and Startup Grind Global; and distribution of informative brochures in retail stores.

**Finance:**

GreenGuard will be most appealing to middle - high income families. As of 2023, there are 129 million households in America, 73 million of which (57%) are middle-high income, making this our reachable market.



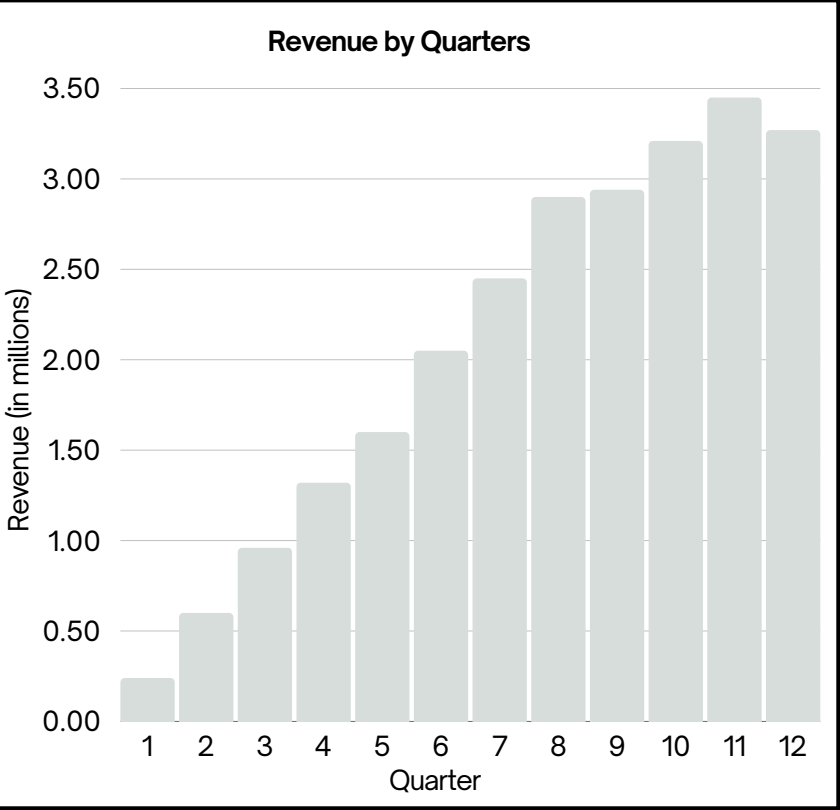
Our initial revenue will be generated through targeted advertisements for our partners, such as HelloFresh and SunBasket (meal delivery services). This would yield; based on our current user base of around 28,000 users, a conservative 0.5% click rate, and an average revenue per click of \$3.50; an annual ad revenue of approximately \$11,520. Our main source of revenue would be product sales. With logistic growth and a large focus on marketing (online and in-store), monthly sales should follow a ramp projection. Each GreenGuard sensor is priced at \$200.00. Based on conservative assumptions, we expect stores in the first month to sell 2 units, then 4, then 6, and so on. This makes our revenue in the first 6 months \$840,000. During the next 6 months, GreenGuard will expand into a total of 200 stores. The original 100 stores are now projected to sell an average of 12 units per month, and the new stores will follow the same ramp projection. This makes our revenue in the last 6 months \$2,520,000

**Sales Projections**

	Year 1	Year 2	Year 3
Units Sold	16,800	45,000	66,600
Sales	\$3,360,000	\$9,000,000	\$13,320,000
Profit	\$1,579,000	\$4,650,000	\$6,190,000

**Investment Opportunity**

GreenGuard is seeking \$1,000,000 in exchange for 15% ownership stake. Additionally, GreenGuard will be raising money through grants including NSF and the Gordon & Betty Moore Foundation. The capital raised will be used to cover the costs of scaling up manufacturing, investing in R&D for new product development, and enhancing GreenGuard’s marketing efforts to drive increased sales and brand awareness.



# Bibliography

- “Ar5 Synthesis Report: Climate Change 2014.” IPCC, [www.ipcc.ch/report/ar5/syr/](http://www.ipcc.ch/report/ar5/syr/). Accessed 7 Jan. 2025.
- Author., and Jean Buzby USDA Food Loss and Waste Liaison. “Food Waste and Its Links to Greenhouse Gases and Climate Change.” Home, [www.usda.gov/about-usda/news/blog/2022/01/24/food-waste-and-its-links-greenhouse-gases-and-climate-change](http://www.usda.gov/about-usda/news/blog/2022/01/24/food-waste-and-its-links-greenhouse-gases-and-climate-change). Accessed 7 Jan. 2025.
- “Carbon Footprint Factsheet.” Center for Sustainable Systems, [css.umich.edu/publications/factsheets/sustainability-indicators/carbon-footprint-factsheet](http://css.umich.edu/publications/factsheets/sustainability-indicators/carbon-footprint-factsheet). Accessed 7 Jan. 2025.
- Durbin, Dee-Ann. “Keep It or Toss It? ‘best before’ Labels Cause Confusion.” AP News, AP News, 7 Oct. 2022, [apnews.com/article/food-waste-best-before-dates-fe1d8ce11c15c40c35c02eefd3526166](https://apnews.com/article/food-waste-best-before-dates-fe1d8ce11c15c40c35c02eefd3526166).
- Lewis, Jangira. “How Does Food Waste Affect the Environment?” Earth.Org, 4 Mar. 2024, [earth.org/how-does-food-waste-affect-the-environment/](https://earth.org/how-does-food-waste-affect-the-environment/).
- Ritchie, Hannah, and Max Roser. “Food Waste Is Responsible for 6% of Global Greenhouse Gas Emissions.” Our World in Data, 18 Mar. 2024, [ourworldindata.org/food-waste-emissions](https://ourworldindata.org/food-waste-emissions).
- “The Ugly Truth about Food Waste in America.” NPR, NPR, 21 Sept. 2012, [www.npr.org/2012/09/21/161551772/the-ugly-truth-about-food-waste-in-america](http://www.npr.org/2012/09/21/161551772/the-ugly-truth-about-food-waste-in-america).
- Workman, Breanna. “What’s the Carbon Footprint of the Foods We Eat?” Recycle Track Systems, 15 June 2022, [www.rts.com/blog/whats-the-carbon-footprint-of-the-foods-we-eat/](http://www.rts.com/blog/whats-the-carbon-footprint-of-the-foods-we-eat/).