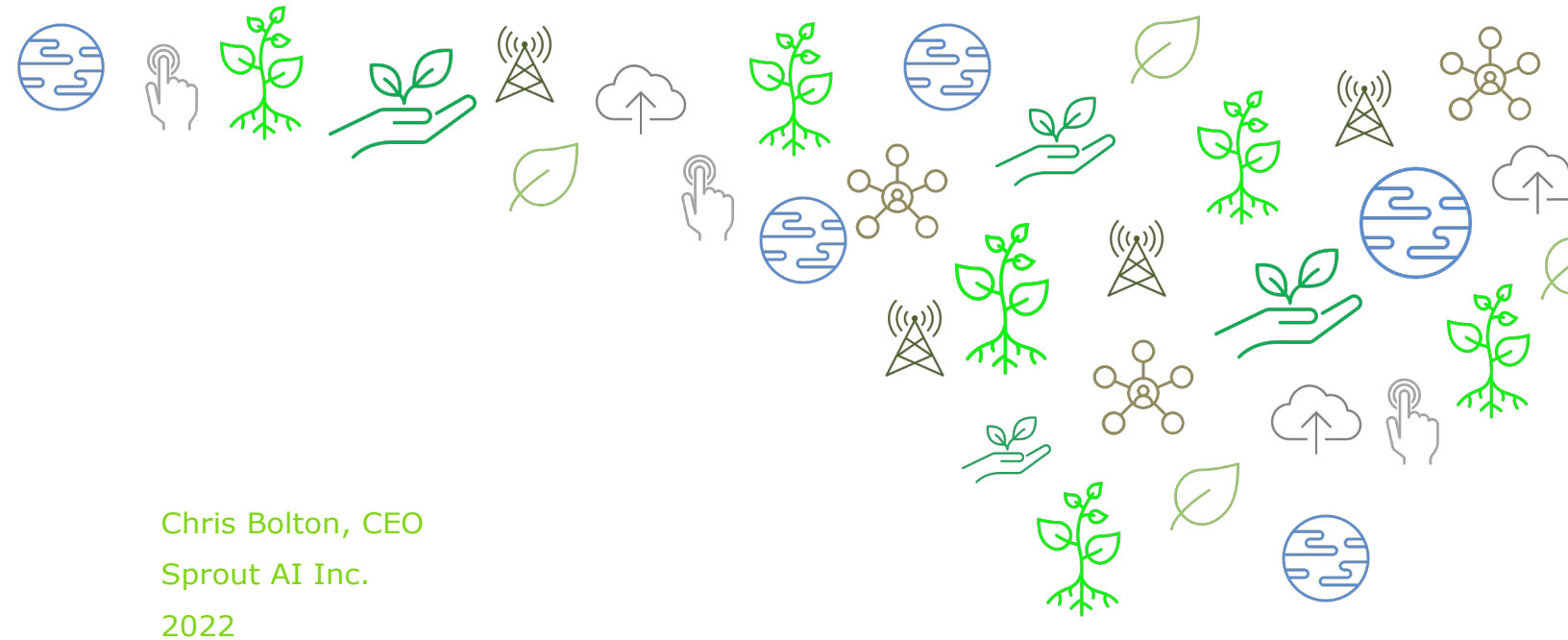
VERTICAL INDOOR FARMING SEGMENTATION WHITE PAPER

Review of Current Segmentation & Future Predictions



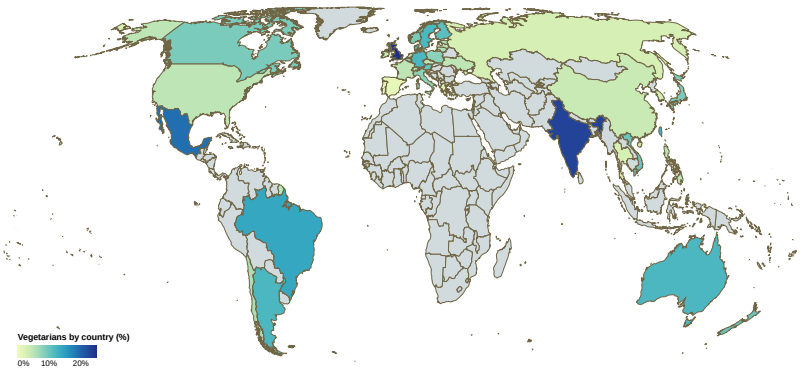
Chris Bolton, CEO
Sprout AI Inc.
2022

Sprout AI
Beyond Farming

The Benefits of Indoor Farming

Indoor farming provides a solution to many factors affecting the current and future food supply chain.
With the vast majority of people living within cities, the cycle time and supply chain cost of shipping field-grown food to cities has become more unfavorable.
As exasperated by the current COVID-19 Pandemic which took hold in Q1 2020, and which continues through the writing of this White-Paper, global supply chains continue to weaken. Cycle time of produce shipped internationally continues to lengthen while the cost of transport continues to increase.
This has cast a spotlight on the percentage of food imported into domestic markets. It is estimated that approximately 80% of the world's population relies on imported food.[1] In 2020 Canada imported CAD $6.66 billion of fresh and frozen fruit[2], followed by another CAD $812.7M in nuts and vegetables. Similarly, the US imports US$14B in fruit and US$9B in fresh vegetables. The UK 11.4B British Pounds for fruit and vegetables.[3]

This marks a substantial shift from the late 1970 production levels when most countries relied on domestic supply. This shift to international vendor/supply chains not only has reduced the shelf life of the produce produced; due to lengthy supply chain cycle times but has also reduced food security, as was shown to be the case when transportation networks were disrupted and/or risk of contaminated products became more evident. By effectively bringing the "farm" back to the people, vertical farming brings the produce in closer proximity to the end consumer, not only ensuring food security but also increase of shelf life. This also presents the opportunity to tailor to the needs and requirements of the local market. In turn, produce produced locally generates revenue that is put back directly into the local economy.



Distribution of Vegan PopulationsBy Georift - Own work, CC BY-SA 4.0,

1 European Scientist, April 28, 2020, https://www.europeanscientist.com/en/agriculture/majority-of-the-worlds-population-depends-on-imported-food/
2 https://agriculture.canada.ca/en/canadas-agriculture-sectors/horticulture/horticulture-sector-reports/statistical-overview-canadian-fruit-industry-2020
3 https://www.statista.com/statistics/316181/fruit-and-vegetables-import-value-in-the-united-kingdom-uk/

DEFINITION OF INDOOR CULTIVATION

Indoor cultivation utilizes space within an enclosed structure to harness and control aspects of mother nature's variables including light, temperature, humidity, nutrients, pests, chemical and biological contaminants by adding, and then strictly controlling, those input vectors. Indoor vertical cultivation goes a step further by utilizing multiple rows or racks within the enclosed space to maximize the cubic area that can be used for cultivation.

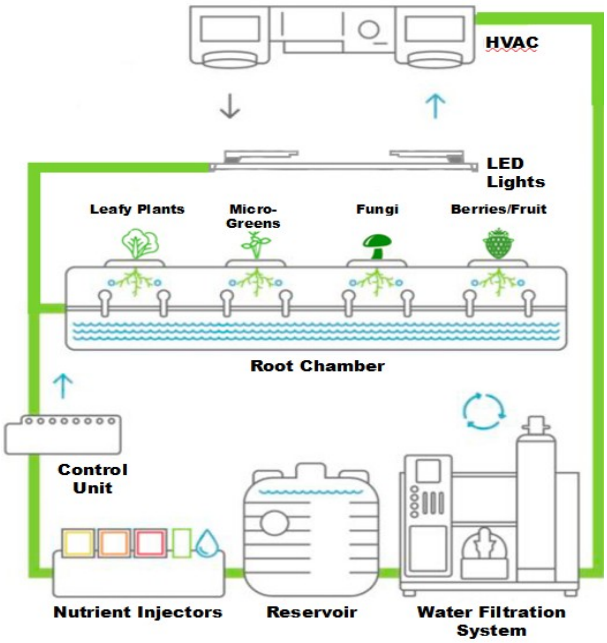
Evolving global market conditions are making vertical farming operations more relevant in today's food supply chain.

The indoor farming industry is expected to achieve significant growth. The global vertical farming market size stood at US$2.13 billion in 2018 and is projected to reach US$12.04 billion by 2026, exhibiting a CAGR of 24.8 during the forecast period.[4]

Both government funding, and the entry of venture capital into the markets, have provided immediate access to capital to help drive this massively disruptive change. The previous reliance on international food shipments has been shifting to in-city production.
This rapid industry expansion is now showing signs of clear segmentation which is the focus of this White-Paper.

Did you know?

Countries like Singapore have committed over $60M as part of their plan to produce 30% of their leafy green / micro-green nutritional needs by 2030 within the city itself.
Singapore's population density of 8356 per Km2



4Fortune Business Insights. "Vertical Farming Market Size, Share & Industry Analysis, By Type (Hydroponics, Aeroponics, and Aquaponics), By Structure (Building-Based, Shipping-Container), By Component (Lighting System, Irrigation and Fertigation System, Climate Control, Sensors, and Others) and Regional Forecast, 2019 - 2026."

Trends in Indoor Cultivation

There is a new space race, but this one is on the ground, that may yet have application back in space. It involves the speed of light development of indoor cultivation technologies that are repeatable, economic, practical, scalable, safe and secure (REP3S).

The world is now casting its attention to technologies that can provide country interoperability, and perhaps in the future, planet interoperability, for food safety and security, banking and anti-money laundering, and full traceability in the event of a recall.

Within less than 10 years the indoor cultivation sector has moved closer to, and often directly within, urban centers. Within two generations, people who left the farm for cities, are now able to have their farms within the city, with them.

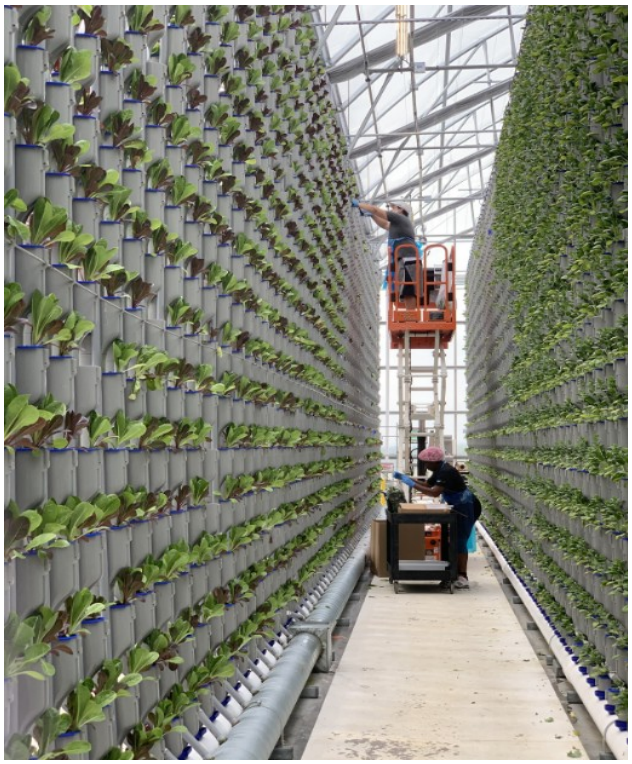
Due to the high cost of real estate, the indoor cultivation sector has been divided between ground level and vertical multi-level cultivation systems. Vertical indoor operations are able to optimize the cost per cubic meter of cultivation space much better than a linear ground level operator.

The race is now on to optimize the other major cost inputs including power, water, fertilizer, labor, processing, and distribution costs and to control those factors using artificial intelligence (AI).

Recently, vertical farming has emerged as an alternative way for providing more plant-based food. This has gained much traction as it take comparatively less time then to traditional farming methods to feed a growing global population amid a decrease in arable land.

A subset of vertical farming enables growing crops without soil (i.e. by using nutrients) in vertically stacked layers under controlled environmental conditions to achieve optimized plant growth, yield, and quality. Typically, the vertical farm may include techniques such as hydroponics, aquaponics, aeroponics, and so forth. Each significantly differs from the other. For example, hydroponics and aquaponics are associated with inefficient water usage therein, while aeroponics requires a very small amount of water, having nutrients mixed therewith, to be provided to the roots of the plant. All employ various systems that are complex, power-consuming, operationally challenging and involve higher labor costs.

A new sub-technology of aeroponics has emerged known as fogponics. Fogponics typically uses a suspension of nutrient-enriched water, supplied in the form of mist, to deliver nutrients and oxygen to the roots for the cultivation of plants having a high yield and quality. In this regard, the existing fogponic systems typically employ an ultrasonic fog producer, that emits a dense vapor that appears similar to fog. However, such existing ultrasonic fogponic systems fail to address the problem due to the heat produced, which can be up to 40°C often results in killing the plants. Furthermore, existing fogponics systems utilize temperature control of the entire system which may not be appropriate for different parts of the plant. These existing fogponic systems often require constant supervision and human intervention in order to maintain pH, humidity, and other growth conditions within the system, thus impacting the quality of the plants. Moreover, the ultrasonic fog producer increases the cost of operation of the existing fogponics systems due to high power consumption. Therefore, in light of the foregoing discussion, there exists a need to overcome the aforementioned drawbacks associated with conventional vertical indoor cultivation of plants.



WHAT ARE THE COMMON FACTORS INFLUENCING INDOOR FARMING SEGMENTATION?

A number of competing factors are influencing innovation, hence segmentation, within the indoor farming sector. These include, but are not limited to:

Local Availability

Achieve consistent, year-round local supply of indigenous and non-indigenous produce that is agnostic to seasons, climates, weather and geographies

Environmentally Friendly

Up to 95% water savings[1], significant reduction in fossil fuel required to plant, sow, fertilize and transport crops, and reduces land use and biodiversity disturbances

Risk Mitigation

Mitigation against natural disasters such as hail and wildfires that can wipe out entire crops, droughts and infestations that can adversely impact yields, and supply chain impacts such as Covid-19

Consistent Quality

Controlled, repeatable growing conditions allow for consistent quality produce that can be rapidly delivered to local markets and reduces the number of perishables from long range shipping

Meeting Organic Preferences

Consumer preferences are evolving to more natural, organic products[2]. The controlled environment of vertical farming reduces the need for chemicals and pesticides

Enhanced Food Safety

Tracking and recall of local produce servin a local market is more manageable than produce grown in international jurisdiction and shipped to a broad network of international markets

Feeding a Growing Population

Up to 100x more productive than traditional methods[3], providing a solution to feed a growing global population amid a decrease in arable land per capita[4]

Technical Constraints

IoT

Developing integrated systems that are designed for indoor operations including water optimization, purification and fertigation, light optimization, dehumidification, air temperature and purification, power optimization within multiple jurisdictions, remote IoT control monitoring and management.

The aim of all indoor vertical cultivation systems should be to provide a solution that satisfies the above sensitivities while ensuring that it also provided is efficient, reliable, eco-friendly, user-friendly, and cost-efficient.

THE ONGOING CULTIVATION TECHNOLOGY PROCESS

Moving from left to right we are seeing a rapid evolution of technologies striving to optimize available resources, reduce costs of operations, while satisfying stringent regulatory requirements imposed during a global pandemic.

HERE ARE THE EVOLUTIONARY STEPS IN USE OF STRUCTURAL SPACE:

Green House:	Green House:	Warehouse:	Sea Cans:	Warehouse:	Warehouse:	Warehouse
Adding rolling tables to optimize linear floor space floor of green	Adding racks to increase vertical growing area	Special purpose open concept warehouse wall of green	Modified to utilize conveyor belts to increase grow area	Sea Cans modified to rack and stack as separate grow rooms	Special purpose open concept warehouse designed to host racks	Special purpose rolling racks used to optimize grow area

HERE ARE THE EVOLUTIONARY STEPS IN METHOD OF INDOOR CULTIVATION:

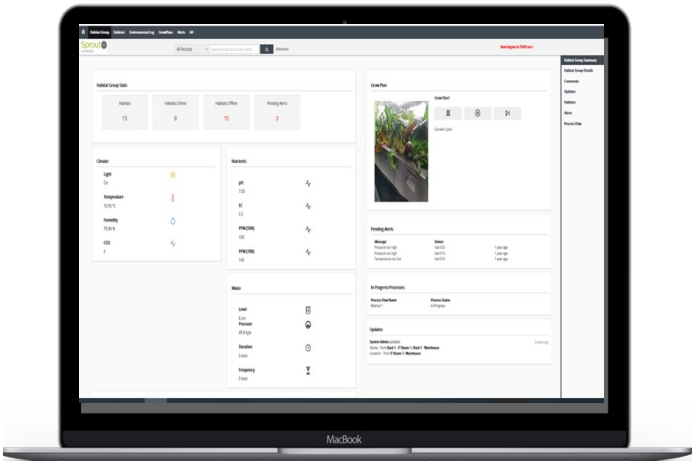
Green House:	Green House:	Special Building:	Warehouse:	Warehouse:	Warehouse:	Warehouse:
Adding supplemental light, black out curtains and HVAC to optimize crop cycle time and yield.	Adding multi-zone fertigation hydroponic drip line and climate control	Cultivate vertically within warehouse on walls or vertical pipe using same light, fetigation and HVAC systems.	Adding indoor racks to fit lights and multi-zone fertigation to increase cubic grow area using same HVAC zone.	Adding shipping containers to isolate HVAC for small batch	Adding rolling racks to eliminate unused isle space	Isolate batches in grow pods, on rolling racks, together with separate environmental and AI controls

Sprout AI
Beyond Farming

1) Columbia University Earth Institute. "How Sustainable Is Vertical Farming? Students Try to Answer the Question"
2) Fortune Business Insights. "Organic Foods Market Size, Share & Industry Analysis, By Raw Material/Commodity (Fruits and Vegetables, Cereals and Grains, Others), By End-use (Bakery & Confectionery, Ready-to-eat food products, Breakfast Cereals, Processing Industry, Others), By Distribution Channel (Direct Market, Processing Industry) and Regional Forecast 2019-2026"
3) Plant Factory: An Indoor Vertical Farming System for Efficient Quality Food Production. Toyoki Kozai, Genhua Niu and Michiko Takagaki.
4) The World Bank

WHAT DOES AI HAVE TO DO WITH IT?

One focus of indoor cultivation has been to produce batched or equal quality, in addition to look & texture. In other words – repeat the batch! That has proven to be extremely difficult given the vast number of variables which impact plant yield, odor, color, texture, and chemical components. To control all of the possible vectors of variation in plant cultivation requires a lot of measurement and subsequent management!



One advantage of indoor cultivation is the ability to measure and then manage causes of plant variation. One such problematic batch is medical cannabis. Most countries that have legalized medical cannabis production require strictly controlled indoor cultivation the must abide by stringent good management practices (GMP). However, slight variations of light, humidity, temperature, nutrient level and schedule, water pH, and electrical conductivity (EC), have been shown to directly impact the primary components of cannabis. Components such as the level of cannabinoids, terpenes, and flavonoids, directly impact the final product efficacy. Being able to repeat batch of cannabis such that the primary components do not significantly vary has been a focus of much development over the last decade.

Managing these factors requires a lot of direct measurement involving sensors that can accurately measure, and report their findings in real-time.

Having an artificial intelligence system (AI) that is capable of adjusting primary vectors to ensure a repeatable batch is a necessity. AI's that adjust to changes in the environment while continually learning to further adjust vector inputs to optimize power, water, nutrient inputs while maximizing plant yield and cultivation cycle time will be the next frontier!

Imagine – Basil produced in 21 days, not over 40 days, that stands 24.5" tall, not 12" tall, that is 6" wide and not 4" wide, using a fraction of water and nutrients!

DOES ESG HAVE A SAY IN ANY OF THIS?

How can it not! Environmental, Social, and Governance (ESG) are major considerations for investors, employees and end customer of any business, including the vertical indoor farming sector. Thankfully, indoor farmings ability to positively influence a number of ESG common targets is notable.

Environmental

According to the Food and Agricultural Organization (FAO) and as recently reported in the UN Climate and Environment COP26 summit "the food supply chain in many countries is on course to overtake farming and land use as the largest contributor to greenhouse gases (GHGs) from the agri-food system." FOA Chief Economist, Maximo Torero concluded "The most important trend…since 1990, highlighted by our analysis, is the increasingly important role of food-related emissions generated outside of agricultural land, in pre and post-production processes along food supply chains, at all scales, meaning global, regional and national levels. This has important repercussions for food-relevant national mitigation strategies, considering that until recently these have focused mainly on reductions of non-CO2 within the farm gate, and on CO2 from land use change".[5] Indoor vertical farming, within the Cities, close to the end consumer, will greatly reduce this impact. In addition, Indoor Farming using the smallest fraction of nitrate fertilizer, does not clear cut forests, or till the land, thus largely reducing greenhouse gas emissions from traditional farming N2O and CO2 output.

Social

Farms within Cities bring food security, as well as provide training for skilled labor, steady work, and when properly designed, provide a showcase for our next generation of students and members of the community to visit and see their "food" being cultivated, processed, and distributed.

Governance

The Indoor vertical farming sector has the unique benefit of being a brand new sector that embraces security, resiliency, procedures and controls, regulatory compliance, values and policies, that align with the needs of their community & ethical requirements.

5 https://news.un.org/en/story/2021/11/1105172

IMPORTANCE OF THE SUPPLY CHAIN WITHIN THE INDOOR FARM SUPPLY CHAIN

For the same reasons that the indoor farm sector is thriving, it too must pay heed to the collapse of international supply chains. All indoor vertical farm operations depend on sources of supply to source, assemble, test, ship, install, and operate within remote City Centers Yet few indoor farm technology providers have factored this universal supply chain collapse into their business plans, purchasing methodologies, or inventory minimum quantities. Here are just a few factors that should be taken into consideration:

Vendor Risk Management

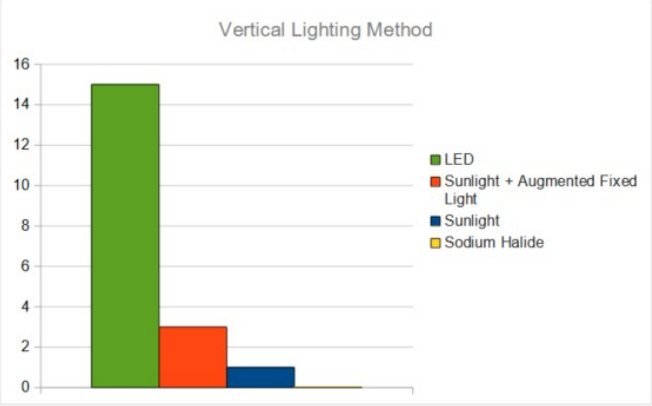
Few indoor farming manufacturers grasp that signing the contract with their third-party equipment and services providers is just the beginning of monitoring risks associated with their ability to deliver on time, and on budget. This risk can collapse a company if they cannot make their orders. A solution is an effective team comprised of a high-performance "third-party risk management program" (TPRM), coupled with the Procurement Office Officer (CPO) and the Chief Information Security Officer (CISO).[6] This is more relevant today given the ongoing country, political, currency and capital market risk instabilities caused by the current global pandemic.

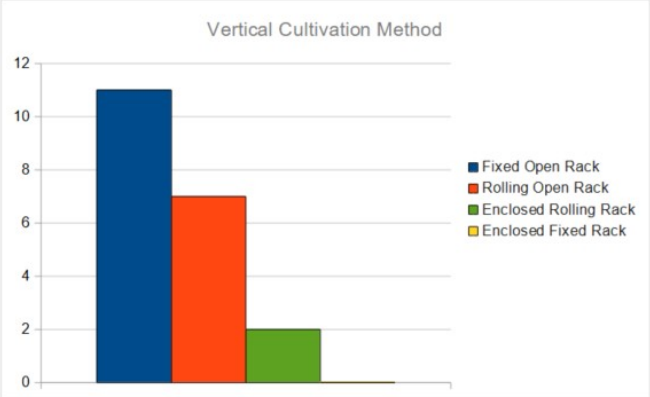
Knowing the status of your vendors is never been more critical. As most indoor solutions require steel, LED's, computer chips (CPU's or PLC's), sensors, and other food-grade products, poor planning may result in a 5-9 months delay in deliveries and / or massive increases in pricing.

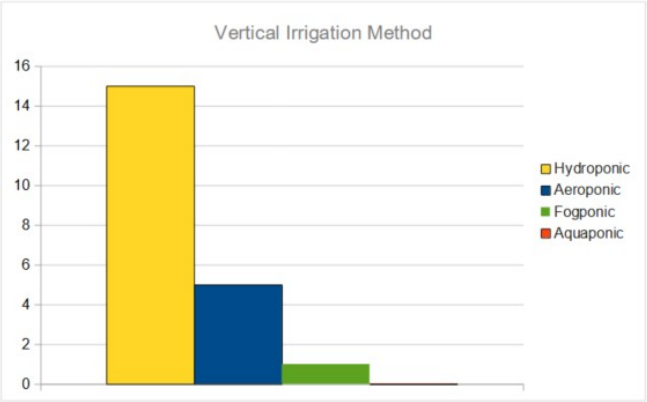
6 ProcessUnity, Best Practices For Ongoing Vendor Monitoring, Tips for Continually Monitoring Your Vendor Landscape, ProcessUnity White Paper

CURRENT COMPETITIVE FIELD COMPOSITION

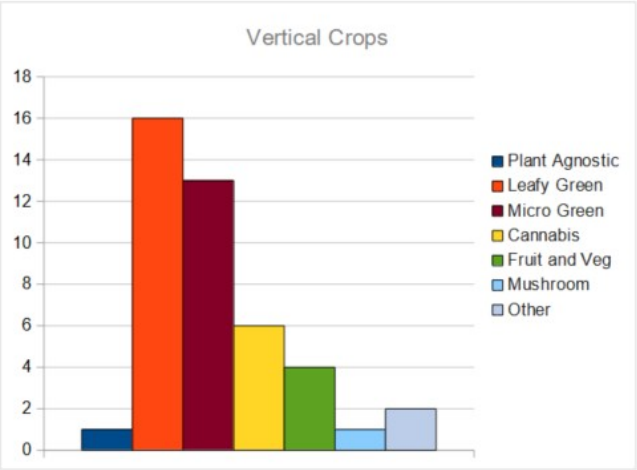
Similar to the formative years of the automobile and aeronautics industries, the indoor farm sector has attracted a variety of competitors. However, unlike the automobile industry that had over 200 years, and aeronautics that had 100 years to emerge and consolidate themselves, indoor farming has had less than two decades to do so. To help showcase the variety and abundance of entrants into this industry we have included in this White Paper a list of the emerging differences. This list is meant to provide insight based on public research and information, thus may not be considered complete due to information not yet made public. As the industry continues to evolve new aspects will be added to this list.

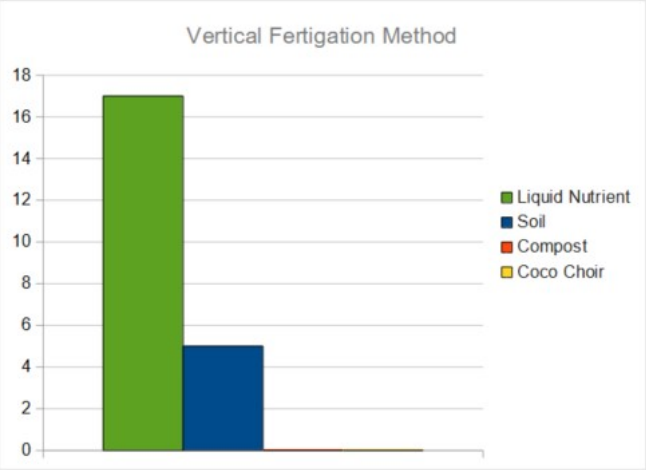


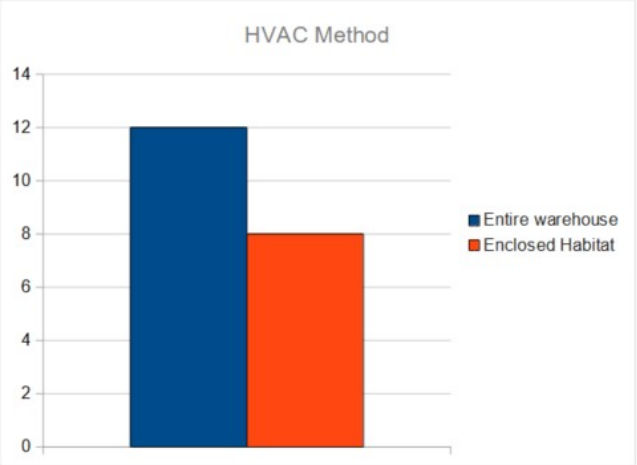


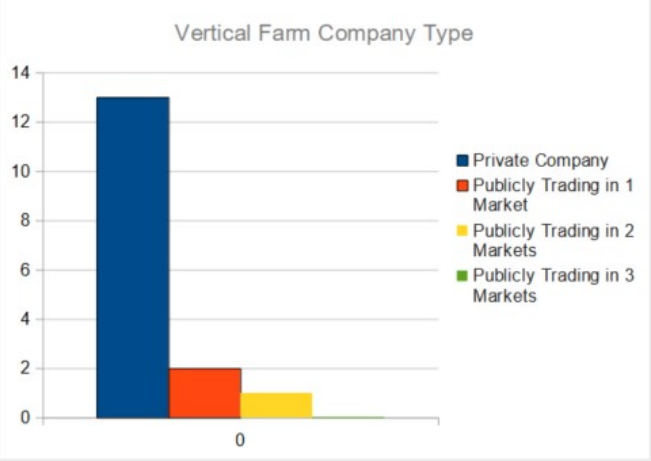


CURRENT COMPETITIVE FIELD COMPOSITION









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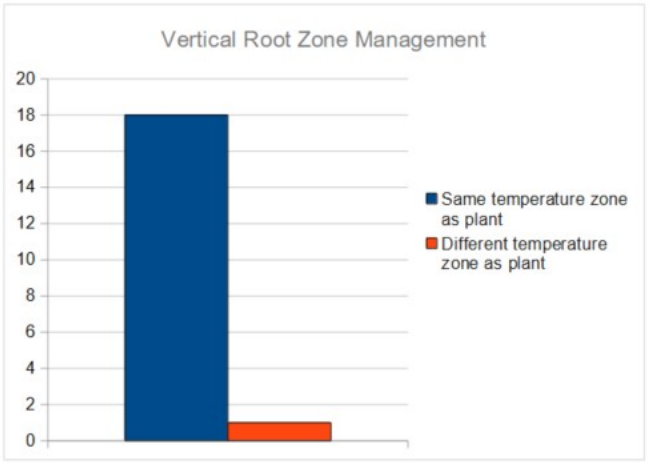
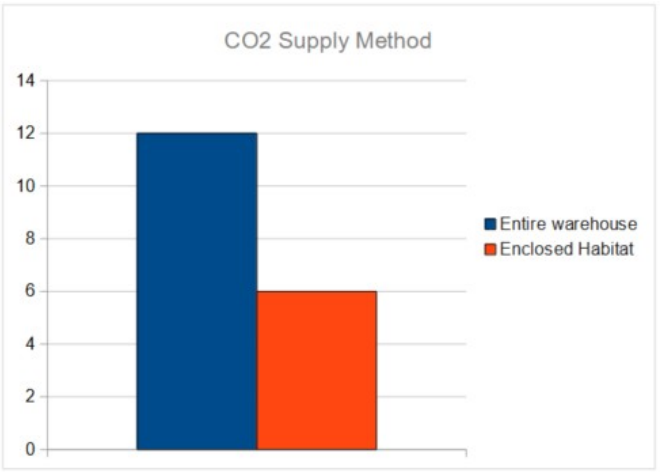
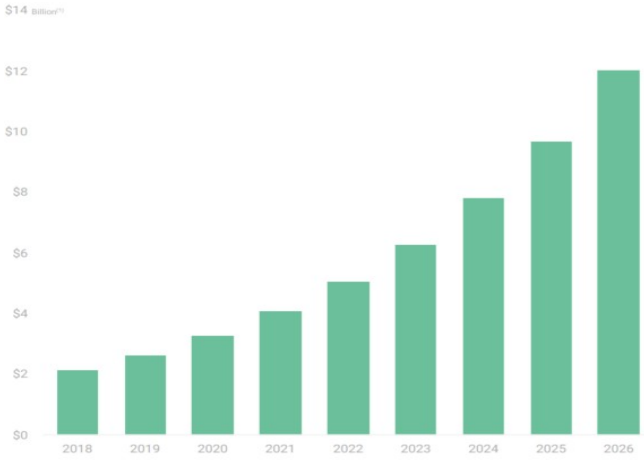






24.8% CAGR to a US$12 Billion Market by 2026[2]

The global vertical farming market size stood at US$2.13 billion in 2018 and is projected to reach US$12.04 billion by 2026, exhibiting a CAGR of 24.8% during the forecast period

THE REP3S DOCTRINE

In this rapidly emerging sector, leaders within the indoor vertical farming market must continue to innovate. However, operating indoor cultivation facilities within a City brings many new challenges in addition to those already undertaken by traditional farming.

Innovation is the key to success in the vertical farming section. However, those innovations must subscribe to the well-known REP3S doctrine as described below.

(1) Repeatable – Not a one-off facilities that are difficult to reproduce in multiple jurisdictions globally;

(2) Economical – Is able to provide early returns on investment and require minimal start-up capital, or can be multi-phase to permit self-financing of additional growing areas within the existing structure;

(3) Practical – Is practical to operate e.g. can be easily serviced, remotely monitored and/or managed, and labor can be easily trained to operate;

(4) Scalable – Is easy to add or subtract cultivation areas to satisfy local demand and project economics;

(5) Safe & Secure – It meets or exceeds EU GMP and OSHA compliance while easily subscribing to the minimum ISO standards including, but not limited to, 31000 (2018), 27400, 17001, and 17025(2017).

PREDICTIONS FOR THE FUTURE

Based on the influence of common factors, rapid evolution, AI, ESG, TPRM, REP3S, and the current segmentation trends of indoor vertical farming previously described, we predict that future facilities will need to incorporate the following to remain competitive through the next decade and beyond:

NO STRANDED ASSETS:

- New buildings constructed for indoor farming will be easily repurposed for other uses, and not be so specifically custom built that they cannot be easily resold in case of need for relocation.
- Technology used within these general purpose buildings must be easily installed **AND** removed.

CUBIC NOT LINEAR:

- Use of vertical m^3, not linear space m^2, reduces cost of production per m^2 as more can be grown vertically with only marginal increase in project cost.
- Use of rolling racks to maximize m^3 can vastly reduce unused and open isle space.

MODULAR DESIGN:

- Ability to utilize an initially small cubic footprint and easily add additional units without having to invest heavily into building design or leasehold improvements.

FAST SET-UP:

- Speed to market and return on investment requires minimum time to set-up and operating.
- The use of pre-existing buildings, minimizing building retrofit requirements, and in case of new builds, provide pre-existing site plans/designs utilizing per-fabricated buildings that have shown to previously work.

ENVIRONMENTALLY POSITIVE:

- Reducing demand on water and preferably adding clean potable water back to the water utility.
- Reducing demand on power and preferably using alternative power switching with ability to add power back to the power grid.
- Reducing transport costs by providing produced product directly to the community will significantly reduce greenhouse gas emissions ($CO2^e$);
- Reduce wastage regarding all aspects of the facilities operations

including recycling of waste plant material, biodegradable packaging, use of renewable power sources generated from production, processing and/or distribution

SHOWCASE FACTOR:

- Designed to be publicly accessible.
- Adding value to the community to show the next generation what what "beyond farming" within Cities really means.

VENDOR AGNOSTIC:

- Able to rely on multiple vendors to provide critical components, processing and distribution technology and/or service requirements to avoid issues related to broken supply-chain.

PLANT AGNOSTIC:

- Permitting any plant to be cultivated within the building in order to provide maximum flexibility in managing local consumer demand requirements.

PLANT BATCH REPEATABILITY:

- Plant factors, including but not limited to, color, texture, crispness, flavor, nutrient value, and shelf life are repeatable batch to batch to satisfy customer expectations.

PLANT IS ORGANIC:

- Plants grown within City vertical farms will not use herbicides or pesticides;
- Plants will be cultivated using pure, uncontaminated, nutrients to enable direct to table delivery without need for washing;
- Manure, compost, or other 3rd party substrates will not be utilized to reduce risk of contamination and / or variation between batches.

MULTI-CROP CAPABLE:

- Permitting maximum number of crops to be able to produce within 1 building maximizes revenue stream opportunities and permits loss leader crops to be added to the mix optimally.

SEPARATED ROOT ZONE:

- A separated plant and root zone permits maximum crop diversity by managing two entirely different eco-zones for temperature, humidity and light exposure.

SCALABLE:

- Easy to add or subtract growing area's to best satisfy local demand.

SAFE & SECURE:

- Easy to measure, manage and report incidents;

- Able to meet multiple regulatory and ISO standards.
- Easy to trace batches for recall.

LOW MAINTENANCE:

- Minimal moving parts that require ongoing monitoring and/or maintenance.

ARTIFICIAL INTELLIGENCE (AI):

- An IoT database and network that is secure, remotely managed, intuitive software that will learn to dial in batch parameters over time to optimize batch cycle time and yield.
- Ability to collect and correlate end consumers with direct access to the entire life cycle of batch information and the ability to provide feedback/requests to further improve batch quality.
- Ability to measure, manage and report changes in key performance parameters either automatically or upon approval of the human operator.

SOCIAL FACTOR:

- As showcase facilities that are located within the consumers' community directly, and designed to service their individual requirements, that are open for visit and review, and offer direct tracking of "their" product from seed, cuttings, or plant tissue culture, through to final destruction, recall, and consumption.
  These facilities are then able to put the farm back into the Cities closest to the people who rely on them for food security and direct feedback.
- Facilities will be located within the same communities that will be purchasing the produced batches and will be operated by people within those communities. Revenues from projects are spent within the community itself, and not sent out of the country.

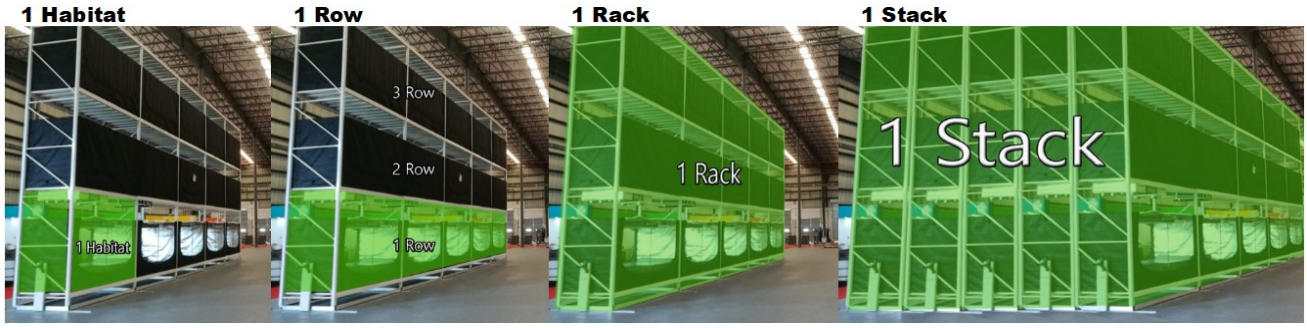
GOVERNANCE FACTOR:

- As regulated facilities, they will be required to provide transparency with regards to their quality, incident reports, and plans for continual improvement.
- These facilities, will be required to be open for inspection at different levels depending on nature and scope of compliance. For example, government food, health, occupational health and safety regulatory, as well as banking regulatory including FATF and FinCEN will require access to ensure good Governance practices are kept.

WHY SPROUT AI?

In response to the above prediction, Sprout AI was purposely designed to ensure:

- ✔ NO STRANDED ASSETS
- ✔ CUBIC NOT LINEAR
- ✔ MODULAR DESIGN
- ✔ FAST SET-UP
- ✔ ENVIRONMENTALLY POSITIVE
- ✔ SHOWCASE FACTOR
- ✔ VENDOR AGNOSTIC
- ✔ PLANT AGNOSTIC
- ✔ PLANT BATCH REPEATABILITY
- ✔ PLANT IS ORGANIC
- ✔ MULTI-CROP CAPABLE
- ✔ SEPARATED ROOT ZONE
- ✔ SCALABLE
- ✔ SAFE & SECURE
- ✔ LOW MAINTENANCE
- ✔ ARTIFICIAL INTELLIGENCE (AI)
- ✔ SOCIAL FACTOR
- ✔ GOVERNANCE FACTOR

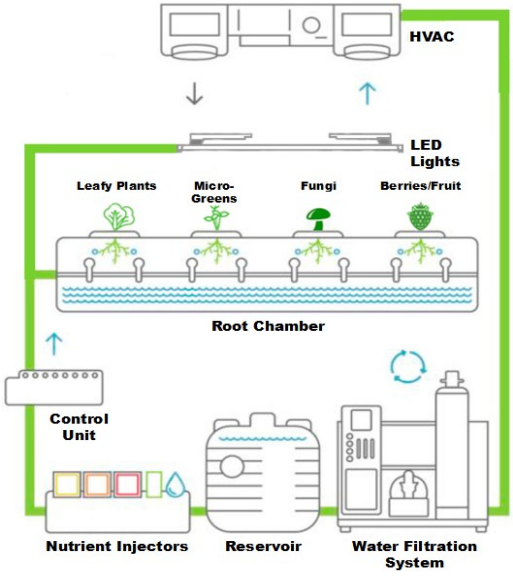


The Habitat Powered By Sprout AI

Sprout AI's cultivation technology is contained within a sealed "habitat" that includes LED lighting to minimize power consumption, advanced air filtration and HVAC, as well as a water recycle system recovering 100%

Each habitat is self-contained allowing for staggered growth plans, which results in greater labour efficiency

The separate habitats also mitigate external and cross-contamination risk and allow for multi-crop farms



Fogponic Driven

Sprout AI uses fogponics whereby the root is suspended in the air and misted with purified, nutrient-rich water. Fogponics uses the least amount of water (vs hydro and aquaponic), has the lowest risk of plant contamination, and provides the roots of the plant with the most optimal way to absorb nutrients

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CONCLUSION

Clear segmentation has begun to take shape in the rapidly emerging indoor vertical farm sector. Lines have been drawn with respect to the building structure and use of cubic space, irrigation, fertigation, plant selection, speed to market, and perhaps most important, integration of all of the primary systems under one common AI.

Like all new fast emerging markets, we do expect these segmentations to crystalize shortly. Although there is currently no clear winner, we have provided a list of those factors which will help better differentiate the current and future leaders, and losers.

ABOUT SPROUT AI

Sprout AI is the leader in indoor vertical farming. Publicly trading in both Canada (CSE: BYFM) and the United States (OTCBB BYFMF). Sprout AI has offices in Australia, Canada, and Panama with its primary assembly provided from the high tech park of Panama Pacifico which is located next to the Panama Canal and provides tax free import and export of Sprout AI components and finished products.

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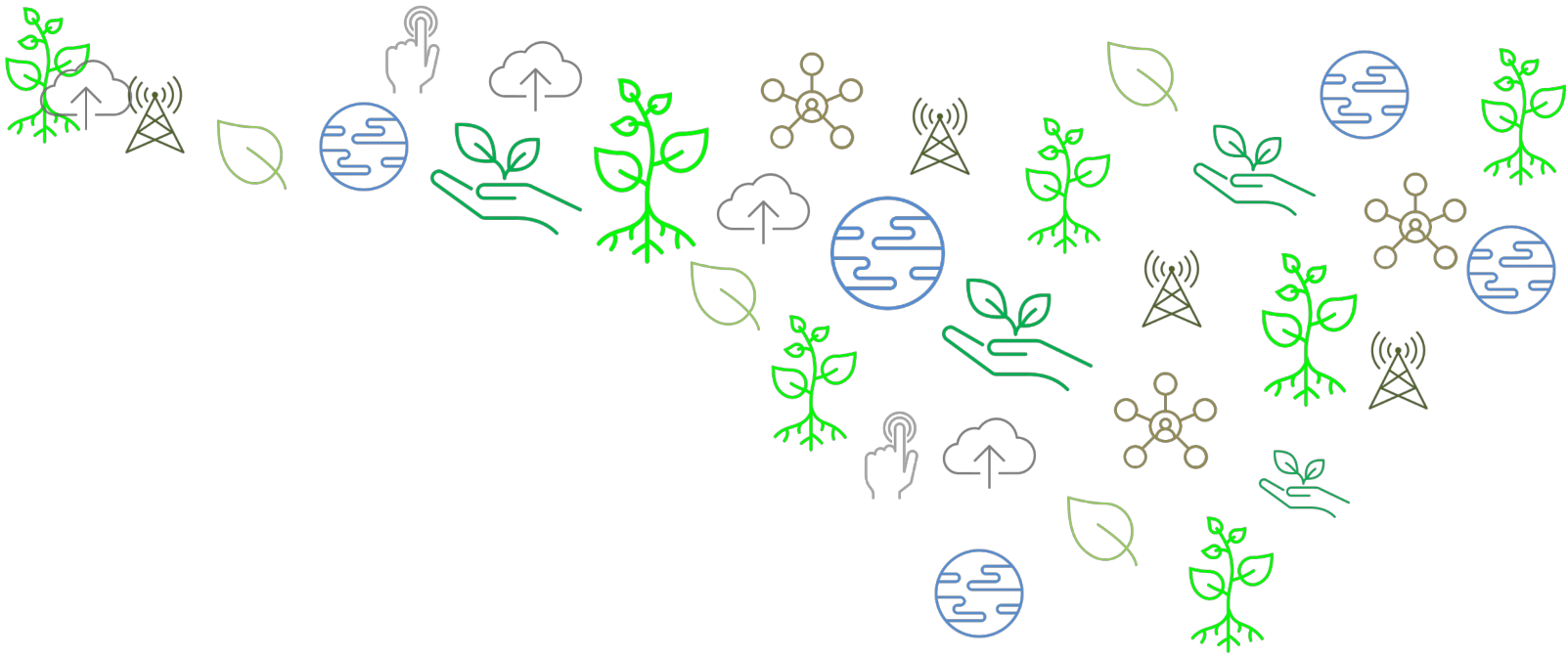
VERTICAL INDOOR FARMING SEGMENTATION WHITE PAPER



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