

2020

Global CEA Census Report

*Challenges, Growth
& COVID-19*





The vision for the Food and Agriculture Organization (FAO) of the United Nations is “a world free from hunger and malnutrition, where food and agriculture contribute to improving the living standards of all, especially the poorest, in an economically, socially and environmentally sustainable manner”.

Autogrow and Agritecture support FAO’s vision and see Controlled Environment Agriculture (CEA) as a key component in achieving that ideal.



Disclaimer

The 2020 Global CEA Census is a joint project of Agritecture LLC and Autogrow. Both parties have done their best effort to encourage participation in the Census among CEA farm operators globally. That said, all participation in the Census was voluntary and none of the information submitted by Census respondents has been verified by any independent sources.

We (Autogrow & Agritecture) are not responsible for the accuracy of the data in the report since it has not been independently verified. We encourage any organization to conduct proper due diligence before making any critical decisions for you or your business.

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The Definitions

The Controlled Environment Agriculture (CEA) industry is still refining its own identity. For the purposes of this report we are using the following definitions:

CEA is the growing of crops while controlling certain aspects of the environment including lighting, temperature, humidity, irrigation, fertigation and other factors that influence plant physiological responses.

GREENHOUSE refers to a climate-regulated structure with walls and roof made out of a transparent material in which crops are grown.

ROOFTOP GREENHOUSE refers to greenhouse located on top of another building.

SHIPPING CONTAINER refers to a climate-regulated shipping container using only supplemental lighting (no sunlight) for crop production.

HIGH TUNNEL refers to crops covered with a canopy for protection against the elements and sometimes referred to as hoop houses or tunnel houses (not small backyard hobby tunnels).

INDOOR FARM refers to crop production that utilizes artificial lighting instead of sunlight. This can include rooms, warehouses, factories and other converted indoor spaces.

VERTICAL FARMING is crop production that uses the vertical space. Plants can be stacked horizontally or in tall towers.

The Report

For this report we have chosen to incorporate other research undertaken by external sources that can give further context to what is a complex industry.

Thank You & Takeaways.

We would like to thank all those who took part in the Global CEA Census and those taking the time to read this report. We would also like to thank the media and industry partners that helped promote participation in the Census.

Like last year, our goal was to get the pulse of the industry, especially during a year where COVID-19 has hugely impacted businesses and all areas of our lives. No one has been left unaffected by the pandemic and we were interested in hearing personal accounts of the challenges during this period of time.

Some of the key takeaways for this year include:

1. CEA businesses showing extreme optimism and resilience in spite of the COVID hurdles (95% with positive outlook; 57% break even or better on crop sales vs. pre-COVID levels)
2. A shift toward CSA (community supported agriculture) / produce boxes helped many farms stave off the impact of losing restaurant & hotel clients. Website request forms & ordering platforms provided the biggest boost for farms able to pull off this shift.
3. There are even more signs that CEA newcomers are here to stay - both in terms of age (88% below age 50) and lack of experience in agriculture (49%).
4. Scaling up still appears to be a challenge, with only about 1/3 of farms cracking the \$100,000 revenue mark, and only 29% finding access to funding (although not all sought funding).

About the Census.

8 WEEKS

This is the second Census to be conducted and ran from 8 July to 4 September 2020. It was promoted through Twitter, LinkedIn, Facebook, Instagram, industry partners and various online media and industry channels.

QUESTIONS

This year was very different to 2019 with the onset of the pandemic at the start of the year. We took this into account by including a section directly related to COVID-19:

- 31 general business questions
- 11 Covid-19 related questions
- 21 bonus questions

20% of this year's participants took part in last year's CEA Census.

58 COUNTRIES

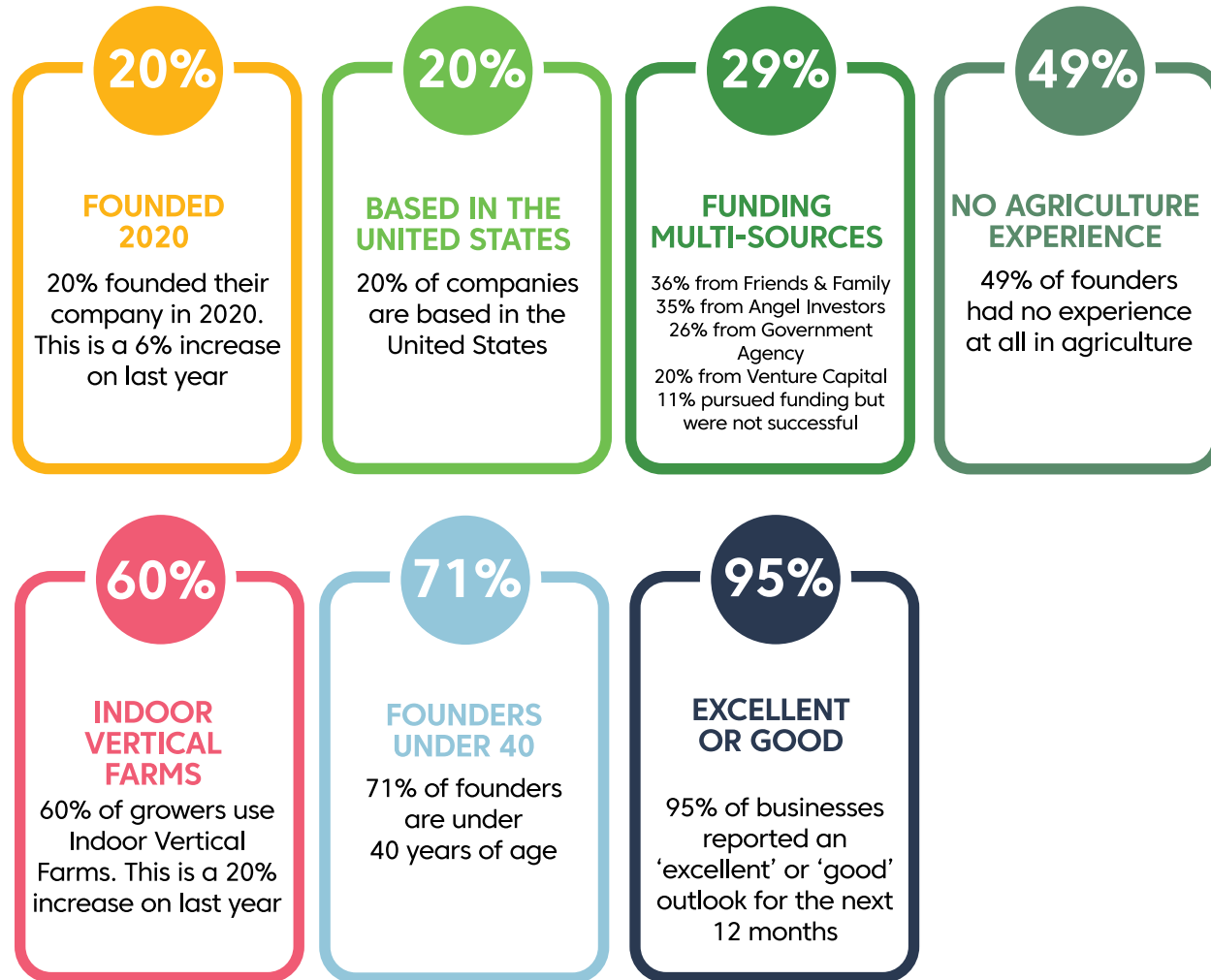
This year we had respondents from **58** countries with the largest percentage from the **United States, India** and the **United Kingdom**.

371 RESPONDENTS

There was a clear bias towards small to medium growers which is unsurprising given the large percentage of farms worldwide are small operations. Respondents ranged from small businesses with revenue under USD\$10,000 to large with more than 100 employees with an annual revenue exceeding USD\$3,000,000.

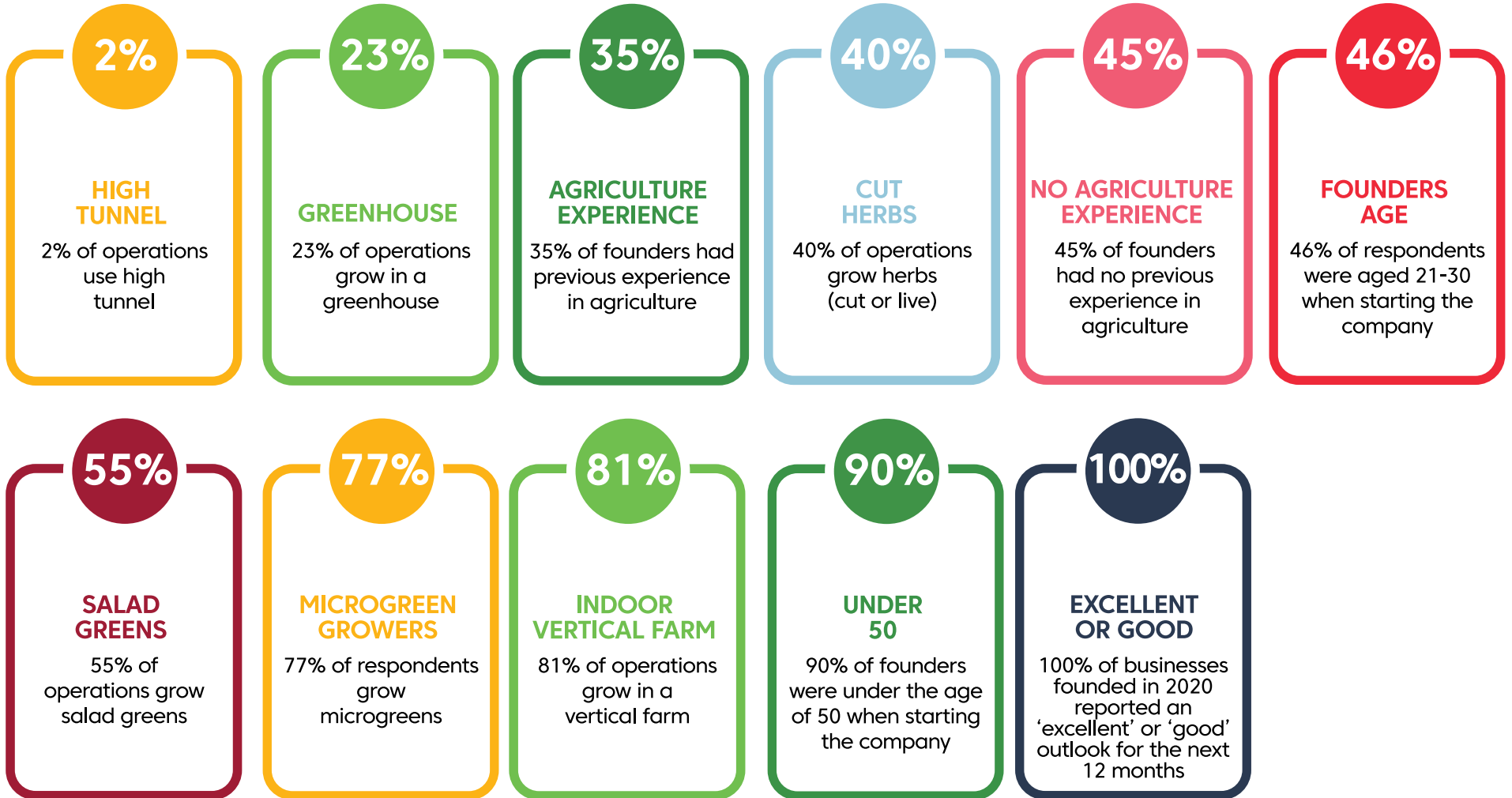
Overall 371 participants.

371 people responded to the survey. Of those here are some of the top statistics:



74 businesses founded in 2020.

This year 20% of respondents started their business in 2020. This is a significant event considering the pandemic took hold during February / March of this year. Of those 74, here are some of the most interesting statistics:

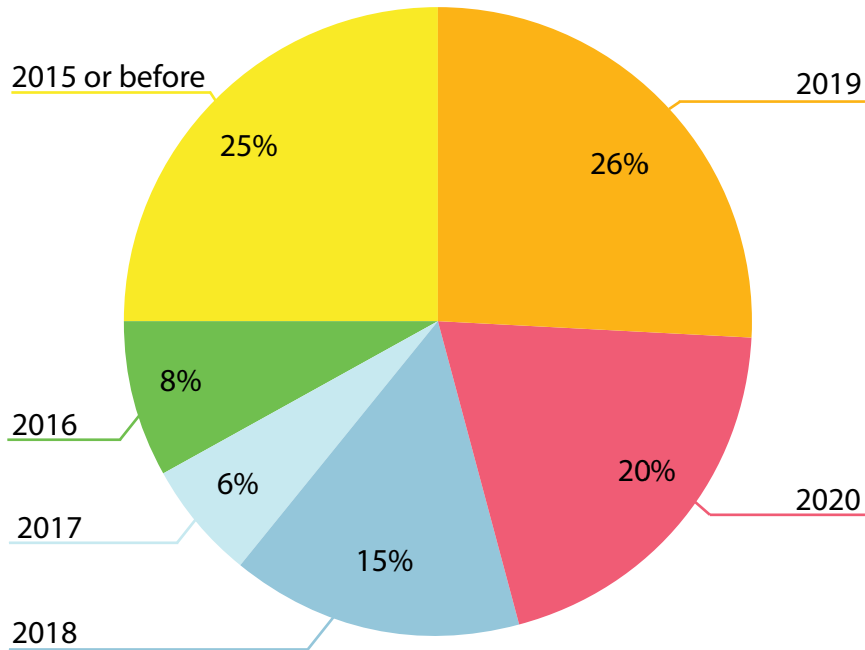




The Farmers.

CEA continues to attract younger generations.

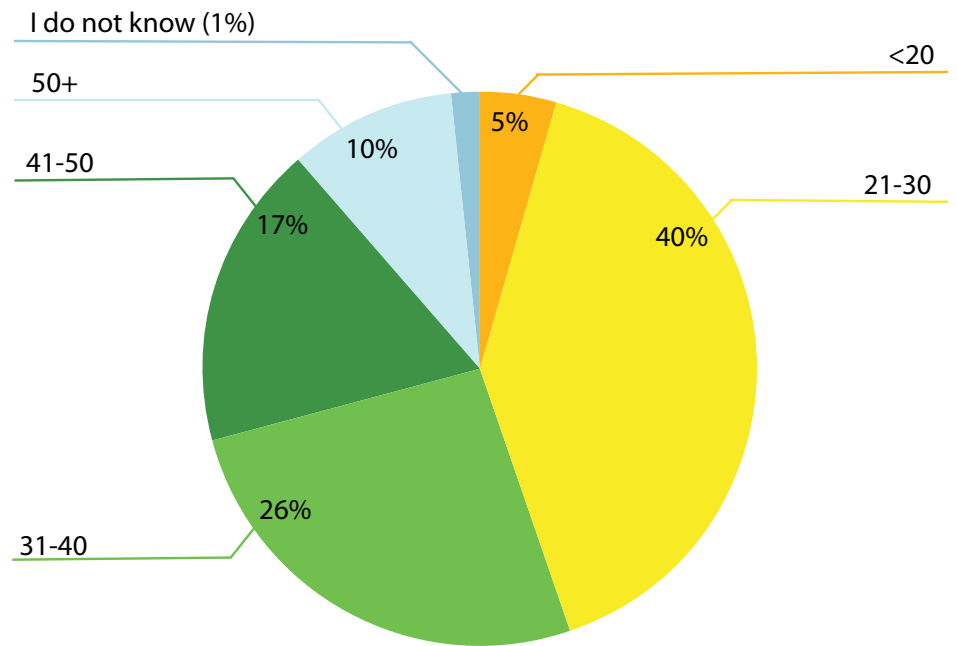
What year was the company founded?



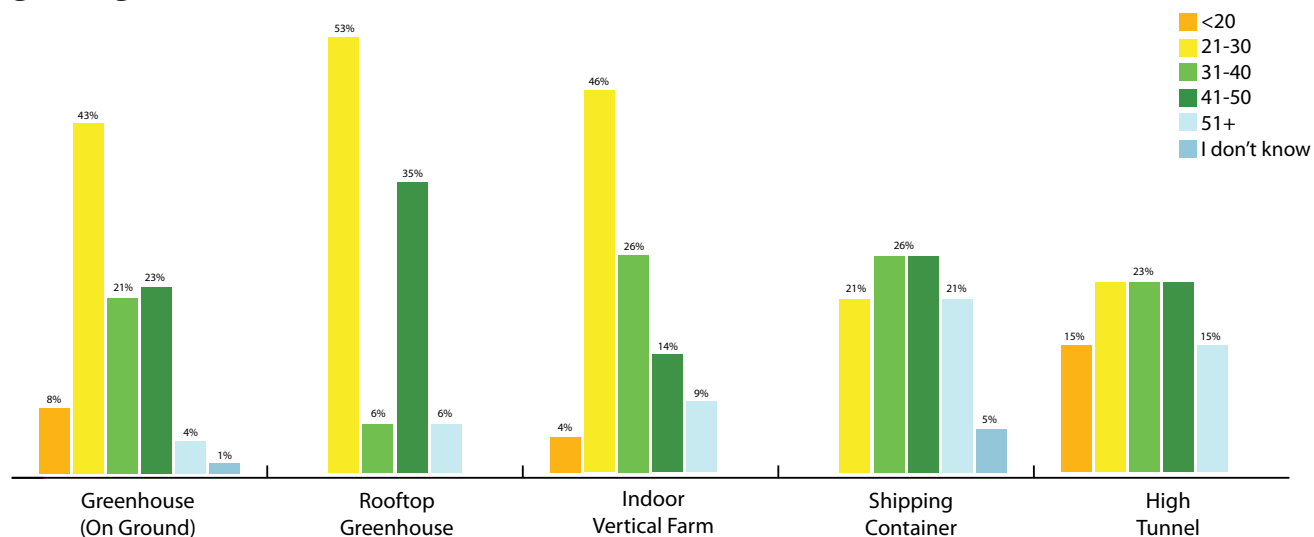
The remaining businesses were founded prior to 2015. The oldest company to take part in the Census was founded in 1901. The results show an increase in activity over the past two years.

Age of the founder when starting the company

2019 saw 60% of founders under 40
2020 has 71% of founders under 40

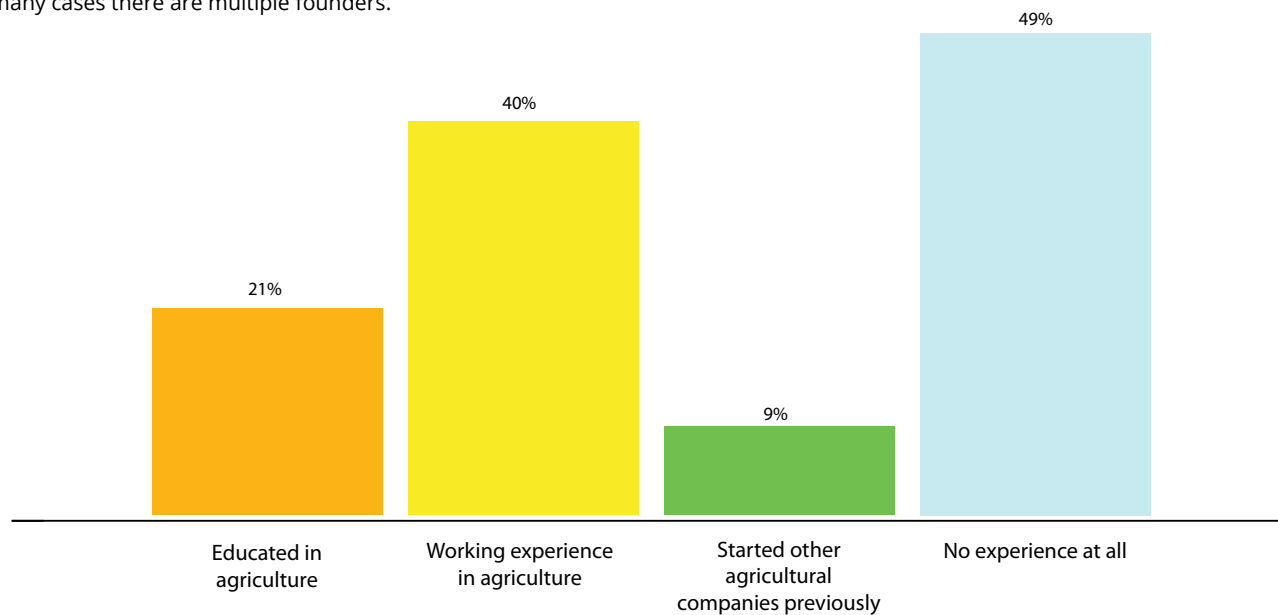


The founder's age when starting the company - by growing environment



What was the founder's experience in agriculture before starting the company?

* In many cases there are multiple founders.

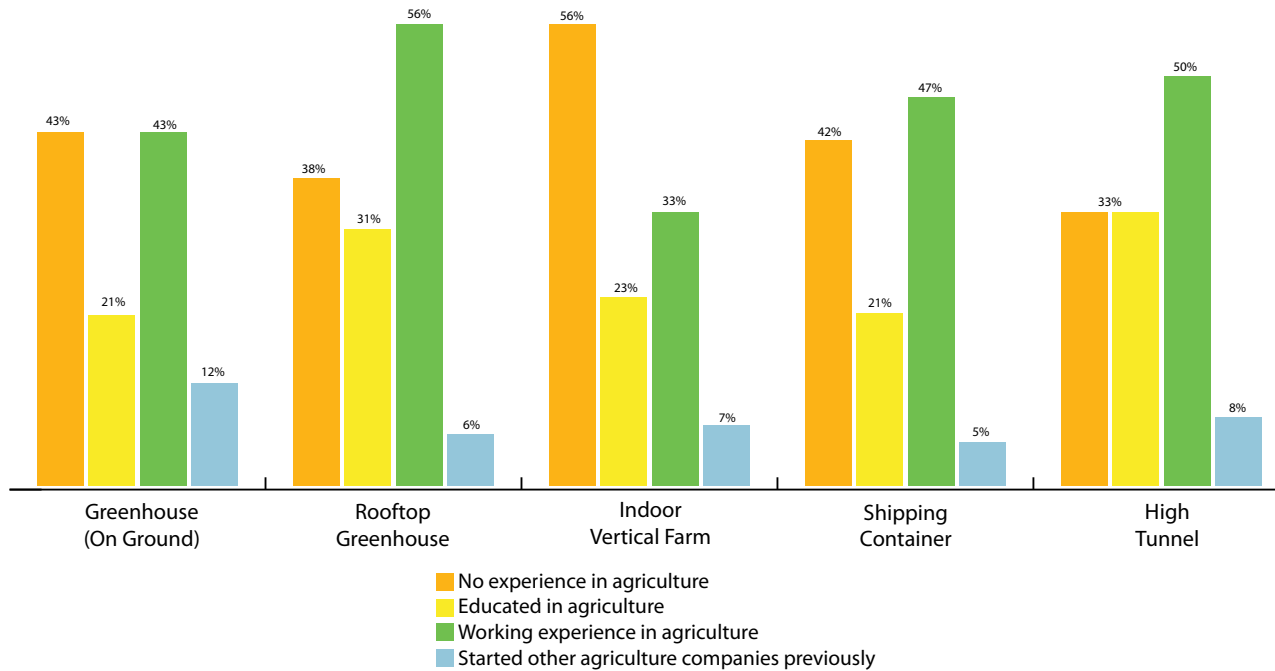


Much like last year's CEA Census, a significant percentage of founders from this year reported having no prior experience in agriculture. Except this year's census revealed that this number was even higher: 49% had no prior ag experience, versus the 41% revealed in the 2019 Census. With nearly half of all founders new to agriculture, the industry seems to have solidified its appeal to newcomers.

Does lack of experience hurt these new business owners? It might. Of farms founded in 2019 or earlier:

- 27% of those businesses founded by entrepreneurs new to agriculture reported that they were losing money, and only 31% were profitable.
- Of those farms with founders who have at least some background in agriculture, only 9% reported losing money and 60% were profitable.

The founder's experience in agriculture before starting the company - by growing environment



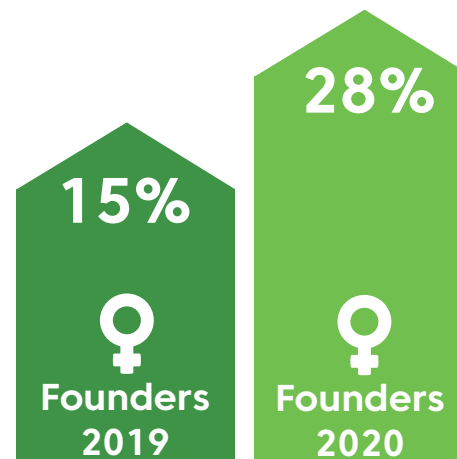
However, one complicating factor is that profitability appears to be closely tied to the number of years a farm has been in business, and a disproportionate number of new agriculture entrepreneurs founded their businesses in the past two years. It appears that the gap begins to shrink as we compare only farms founded at least three years ago (note that the sample size once you go this far back is relatively small).

One issue this does underscore is the need for educational programming as well as planning and operational expertise to help new farming entrepreneurs avoid costly initial mistakes and hit the ground running.

Women in agriculture on the rise

The United Nations notes that on average women represent 43% of the world's agricultural labor. There is no definitive number on what percentage of those are in CEA (Controlled Environment Agriculture) however we speculate that it would be less than 5% globally.

* In many cases there are multiple founders.





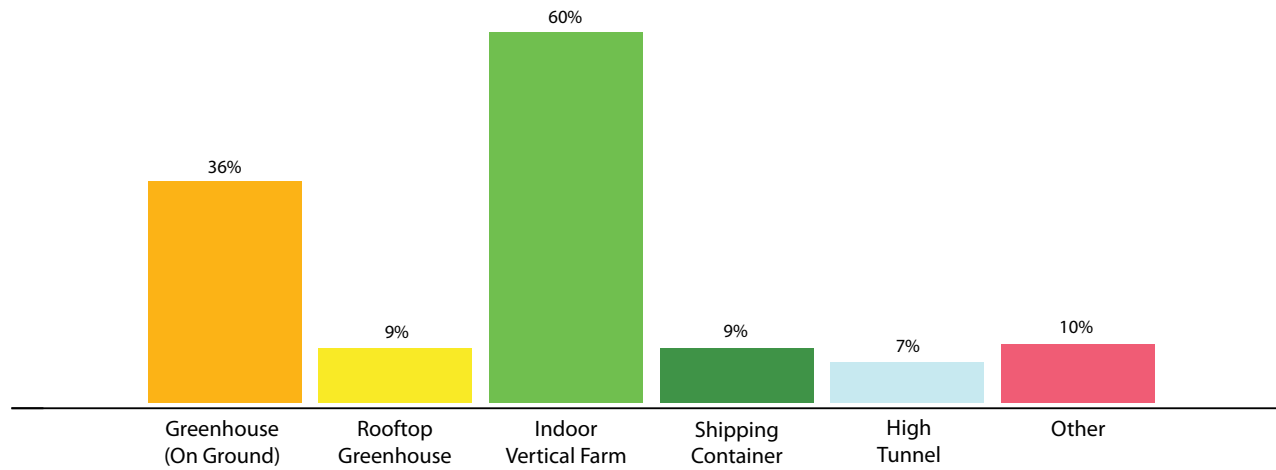
This year respondents from **57** countries took part with:

- 20%** of companies based in the United States
- 15%** of companies based in India
- 7%** of companies based in the United Kingdom.

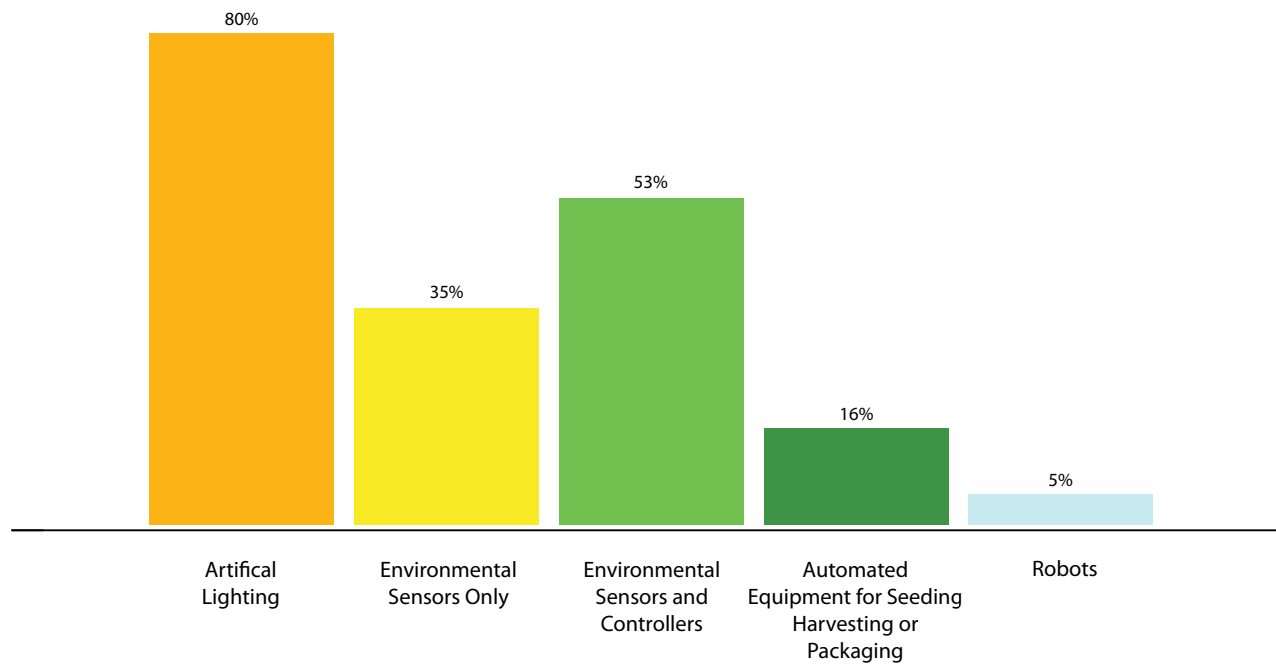
The Farms.

What type of CEA facility do you use for cultivation?

* Operators utilize more than one facility type.



What type of technology is used in your operation?



What crops are being grown.

The respondents from the Census produce a range of crops including:

1%

Tree nuts
(Almonds, pistachios, walnuts, etc)

4%

Tree Fruits
(Apples, pears, peaches, nectarines, cherries, etc)

4%

Root Starch vegetables
(Potatoes, yams, sweet potatoes, etc)

4%

Cannabis

6%

Ornamental plants

7%

Melons
(Cantaloupe, watermelon, etc)

9%

Squashes or gourds
(Zucchini, pumpkin, etc)

9%

Mushrooms

10%

Nursery starts

10%

Broccoli or Cauliflower

11%

Root vegetables
(Carrots, radishes, beets, kohirabi, etc)

14%

Berries
(Raspberries, Blueberries, Strawberries, etc)

25%

Vine vegetables
(Tomatoes, cucumbers, peppers, etc)

53%

Herbs
(Cut or live: mint, oregano, rosemary, etc)

53%

Other leafy greens
(Chard, kale, cabbage, etc)

66%

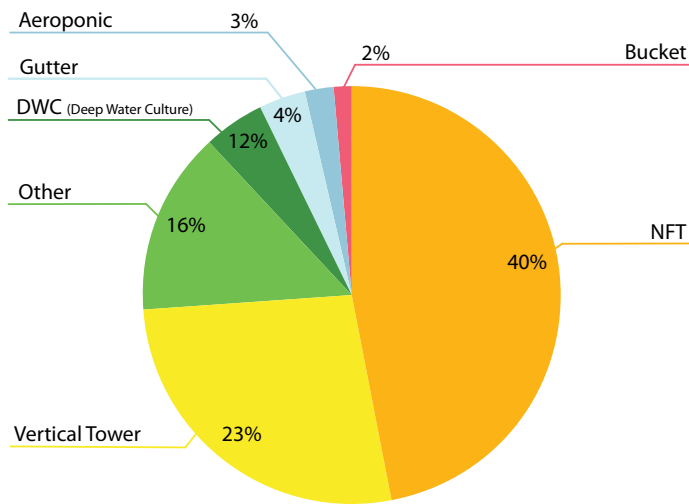
Microgreens

68%

Salad greens
(Lettuce, salad mix, spring mix, arugula, etc)

Crop production systems

The most common grow system reported by respondents was an NFT (Nutrient Film Technique) production system. This is not surprising since greens was the most common crop type being produced. Of the respondents, 53% produce herbs, 68% salad greens and 53% other leafy greens. NFT systems are a good-performing and cost effective system for greens production. 40% of overall operators produce using an NFT system.



An interesting note relating to system type is the continuing emergence of vertical tower systems for commercial production. Of Census respondents, 23% reported that they use some sort of vertical tower system. Tower systems have several challenges related to commercial production that NFT systems do

not face and it is interesting that growers are potentially overcoming these challenges to use this technology in commercial production - or, perhaps, continuing to choose these systems despite the challenges.

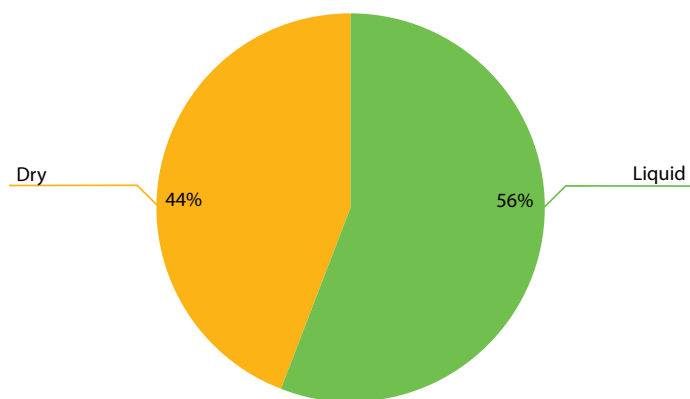
One major challenge of tower systems can be uneven distribution of light to the plant sites throughout the tower. Conversely, using NFT systems, creating an even distribution of light via sunlight in a greenhouse or artificial light, is pretty easy to do.

Vertical systems have challenges because if light is coming from above, the upper plant sites will receive more light than those below and the tower will shade some plant sites depending on the location of the lights. Vertically oriented lights are an option that are used in some container systems and larger commercial operations but this can present challenges relating to air flow and access to plants for maintenance or harvesting.

Farming on a vertical plane is another increasingly common practice, used by some commercial systems and commercial producers. It allows for a full utilization of vertical space but access for harvesting and system maintenance can be an issue.



Relating to nutrient use, a slight majority of Census respondents said they utilize liquid nutrients vs dry nutrients.



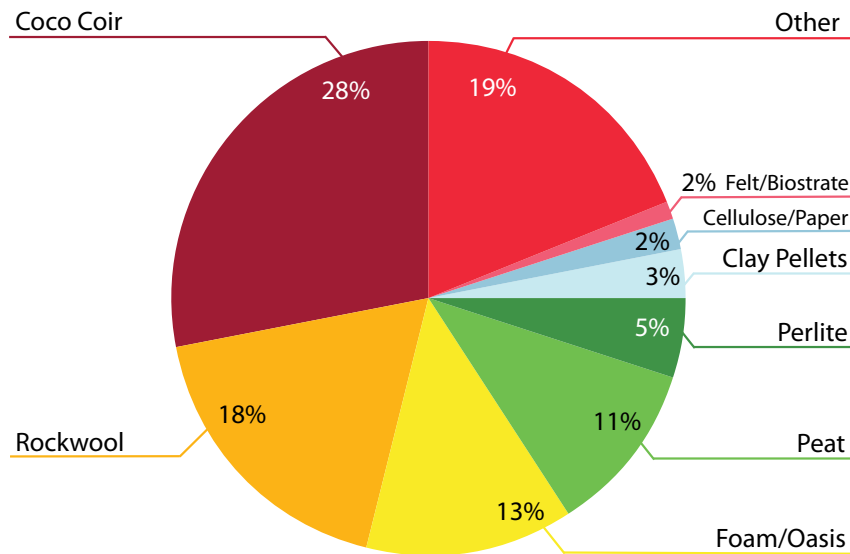
This might be attributed to several factors.

- Liquid nutrients are easier to use for operations that are starting out. Many of the operations answering the Census were founded in the last couple years and many founders have no previous agricultural experience. Liquid nutrients take less understanding of nutrient management and so are a common choice for new growers.
- Soluble nutrients for organic production are often only available in liquid format, unless a grower is creating their own proprietary nutrient brew. While this year's Census did not ask about organic production, 23% of last year's respondents were either certified organic or in the process of certification.



A third interesting insight regarding consumables is related to substrate use.

According to respondents of this year's Census, substrates made from Coco Coir is the most commonly used type of substrate, overtaking rockwool by 10% points. Coco Coir is a popular selection due to its low cost and ability to be used in many formats (slabs, plugs, loose, etc) and easily mixed with other substrates such as perlite for fruiting crops. Coco Coir is also eligible as a substrate for operations with organic certification while rockwool is not. It is perceived to be a more sustainable choice than both rockwool, due to a lower carbon footprint, and peat, due to the mining of peat from wetlands.¹ Coco Coir is made from a waste product of the coconut industry. The Census also noted many respondents using mixes of the above media to create their own custom blends and additional substrates such as jute, bark, fabric and agar.



¹ The rockwool manufacturing process is an energy intensive process of heating rock and assumed to be more carbon intensive than that of manufacturing coco coir. The mining of peat from Canadian and European wetlands is also seen by many people in the horticultural industry as being unsustainable. An analysis that considers the carbon footprint of each and other sustainability considerations was not found prior to the writing of this report.

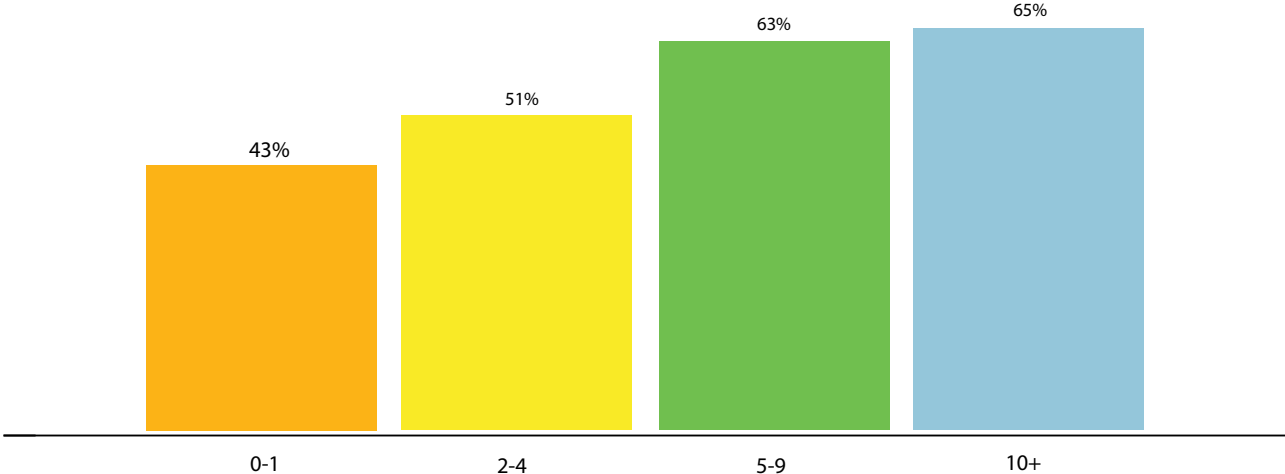




Funding & Financials.

General Revenue & Profitability Trends.

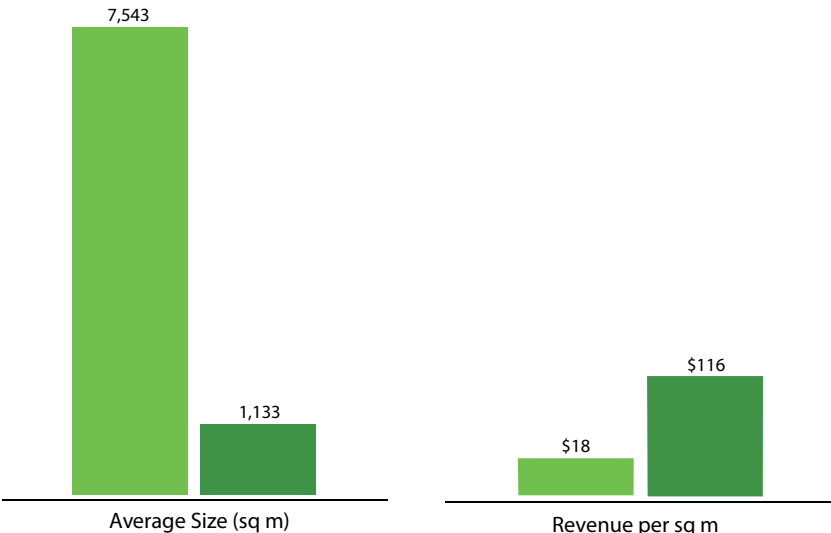
% of Farms Reporting Profitability vs. Years in Business



Average Farm Revenue: GH vs VF



Average Farm Size x Revenue per m²



GH
VF

Of farms who reported revenue for 2020, the CEA Census explored several key metrics around profitability and size for both greenhouse and vertical farm operations.

Out of the 95 greenhouse respondents that have earned revenue in the last year (this includes high tunnel operations), 47% reported that their business is profitable despite disruptions due to COVID. Considering the significant changes around labor and supply chain that many operations were forced to implement, having nearly half of businesses successfully find ways to maintain some level of profit in the midst of the pandemic is encouraging for 2021 and beyond. Beyond farms who reported profitable operations so far, an additional 31% claimed to be breaking even, which also indicates the resiliency and promise for the industry going forward. The remaining fifth of farms that either reported losing money or are currently unsure of their financial situation may be poised to learn from some of the effective strategies utilized by other farms surveyed such as pivoting to new distribution channels and rapidly restructuring workers.

One of the strongest predictors of profitability was the age of the business.

Here's how this compares across different business age brackets:

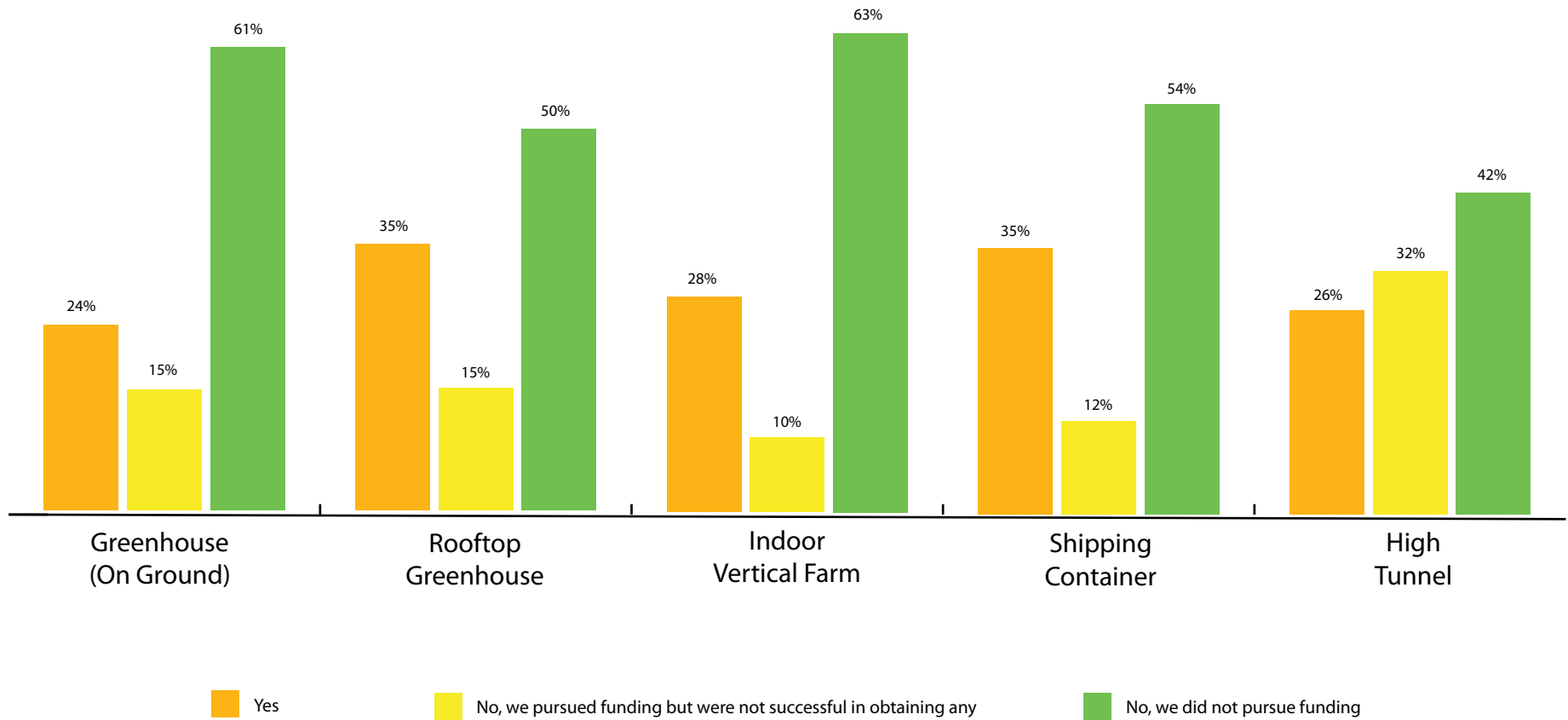
- 0-1 years old - 43% profitable
- 2-4 years old - 51% profitable
- 5-9 years old - 63% profitable
- 10+ years old - 65% profitable

Average revenue among greenhouse growers was \$133,757 annually, with an average farm size of 7,543 square meters and average revenue per square meter of \$18. Similar to greenhouse operations, a strikingly high percentage of the 128 vertical farm respondents that were post-revenue reported profitable operations. 53% of vertical farms surveyed reported being profitable, while an additional 20% reported breaking even. The average revenue among vertical farm businesses was \$131,885 annually - nearly identical to the average from greenhouses - while the average farm size was significantly smaller than greenhouse respondents at 1,133 square meters and an average revenue per square meter of \$116.

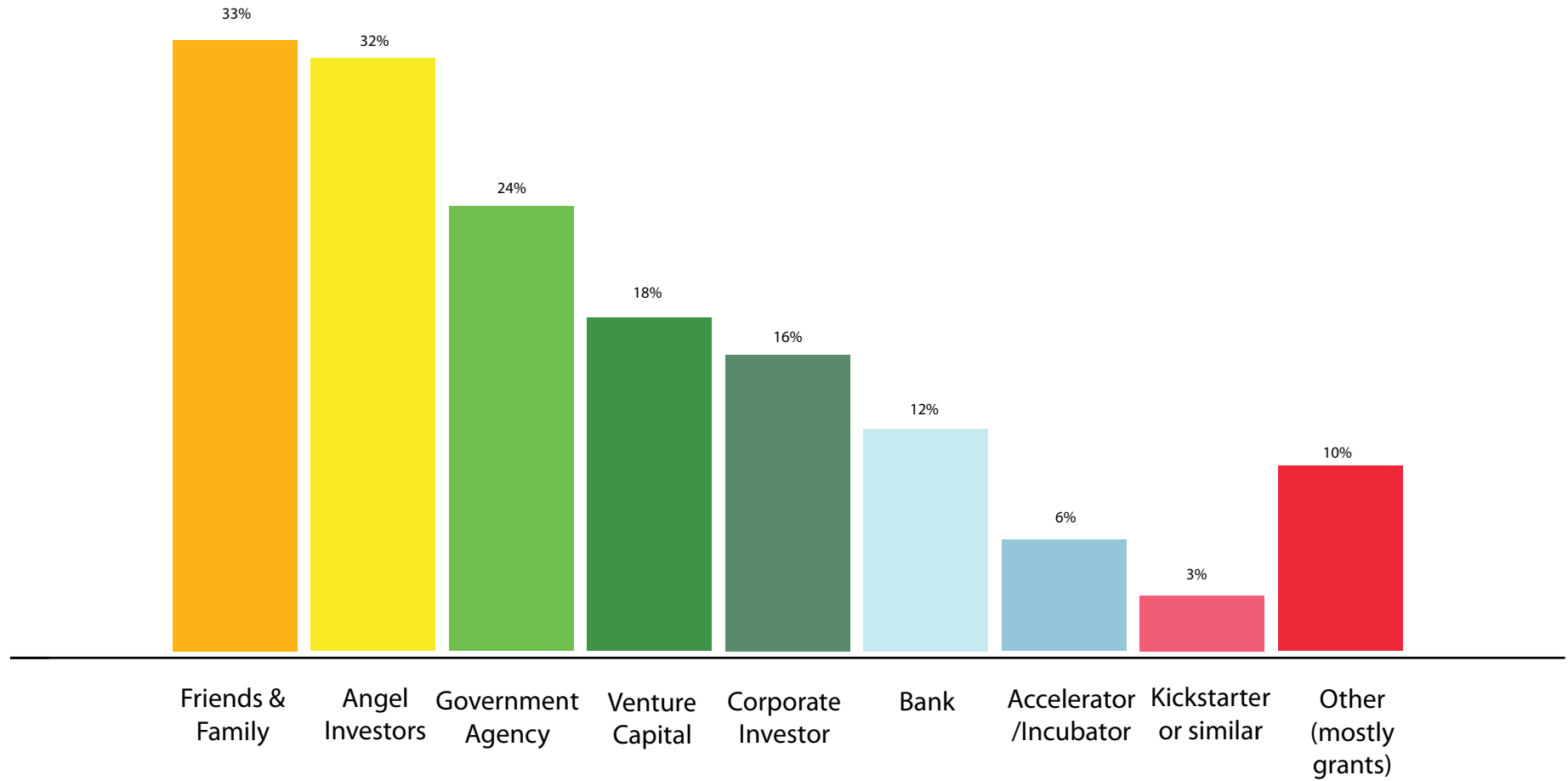


Of farms that were founded in 2018 or earlier, the Census asked owners to consider how their operations have changed over the past year due to COVID.

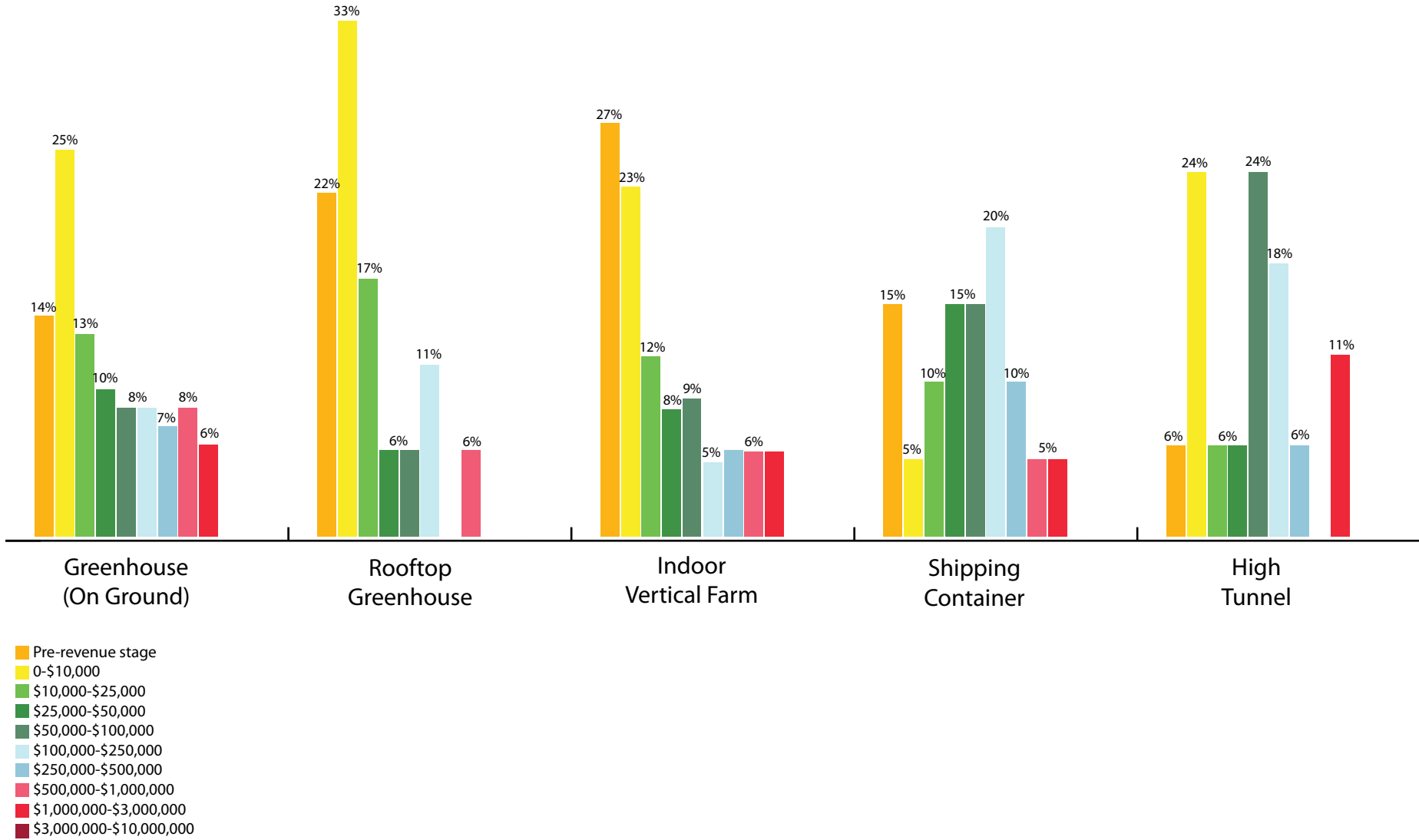
Has your operation received investments/funding in the past (or in the past year, if you answered the 2019 Census)?



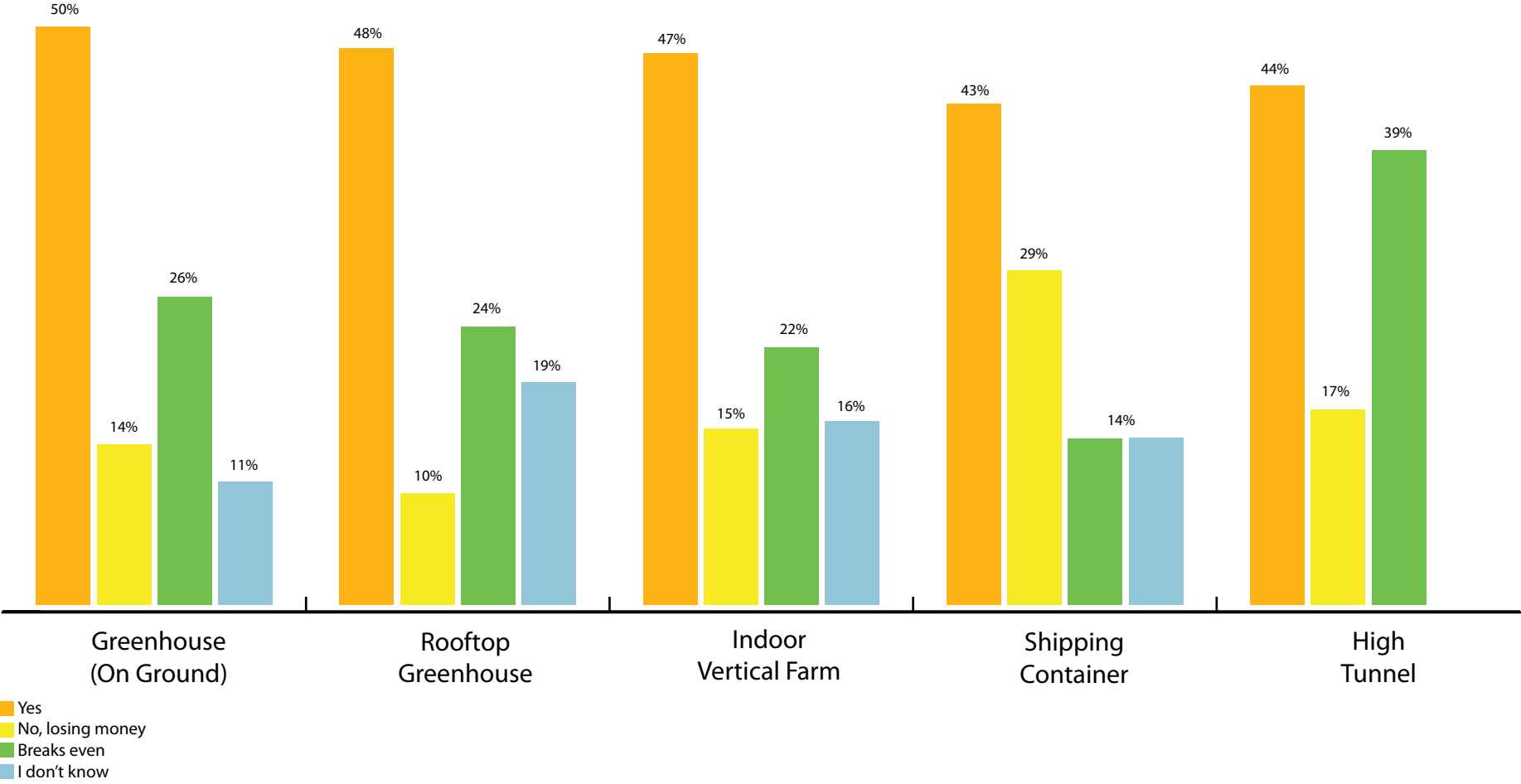
What type of funding was received?



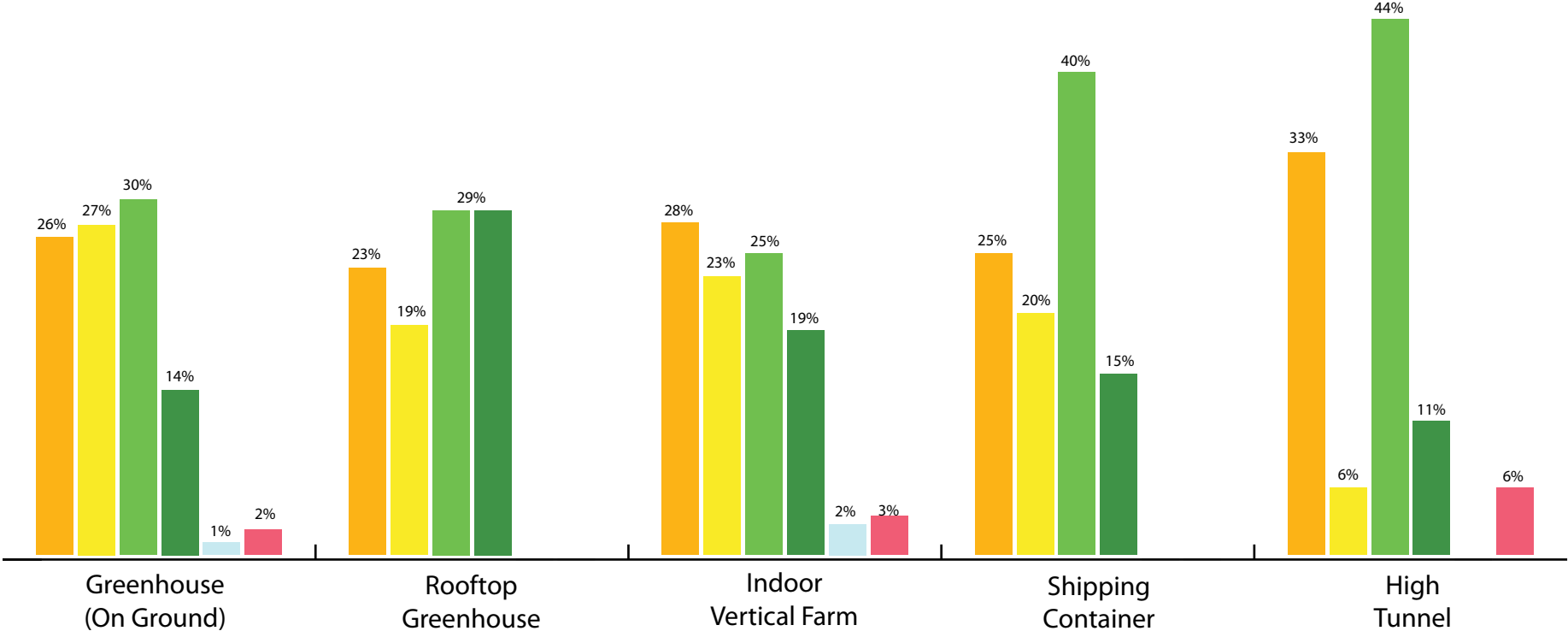
What is your approximate annual sales revenue from your operation (in USD)?



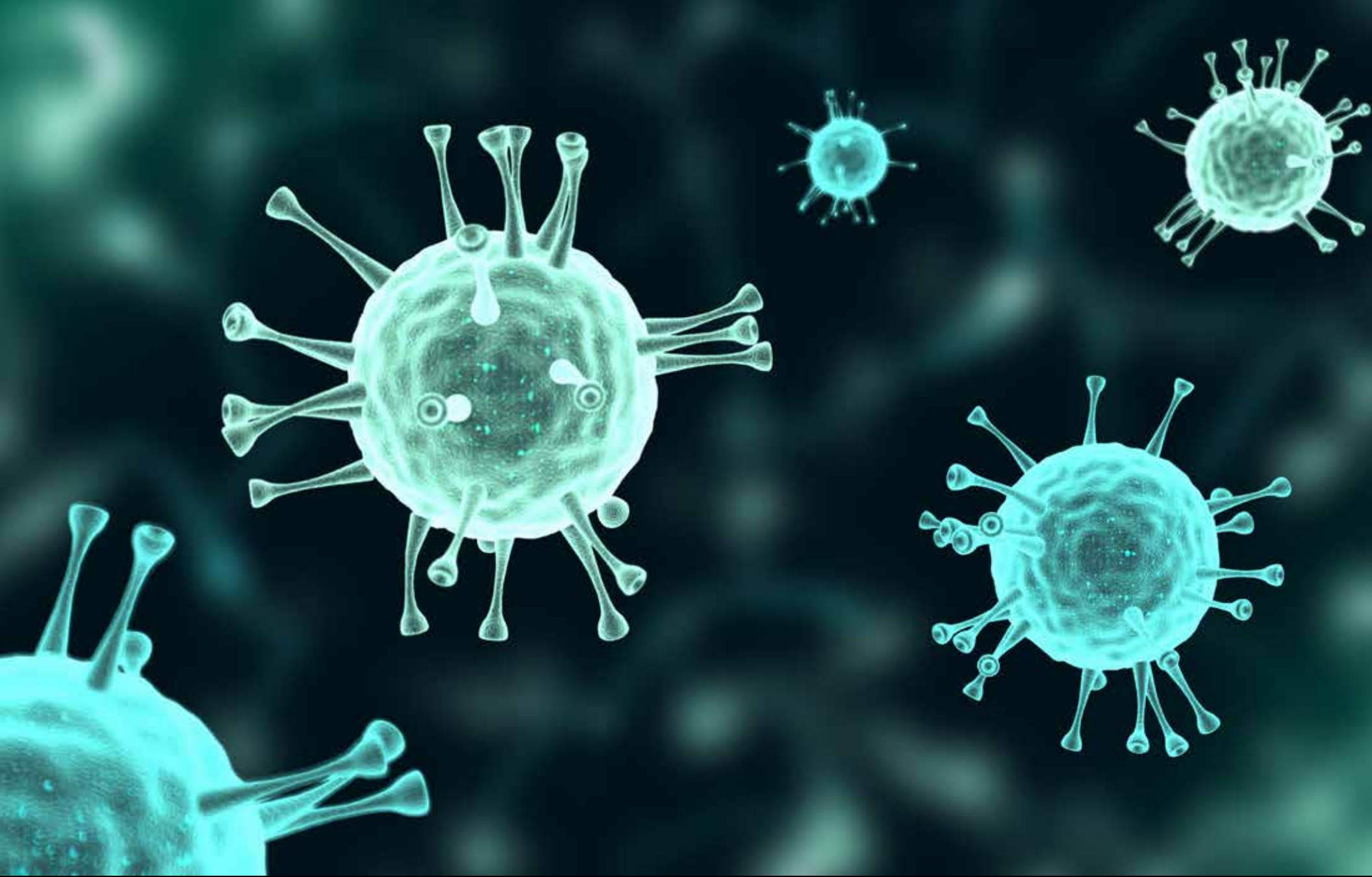
Is your operation profitable?



If you were given a sizeable loan today how would you spend it on your farming business, if you could only choose one option?



- Expand current operations - growing the same products
- Expand current operations - diversifying into new products
- Invest in new technology or equipment
- Invest more in marketing & sales
- Hire additional farm laborers
- Other



The COVID Effect.

When COVID-19 sees your customer-base plummet to zero: The story of Pocket Herbs.

The highs and lows of growing have never been as evident as the past year for Australian micro-herb & bushfood grower Pocket Herbs.

When COVID-19 hit, business dried up along with their customer base – the food service sector.

“When restaurants closed in March, we plummeted to zero customer orders. As one of the biggest employers in the south of Tweed Shire we had to immediately reduce our workforce from 25 down to eight. It may not seem a lot but in this area, it had a massive impact,” says Founder of Pocket Herbs Iain Reynolds.

“It was a horrific situation to be in and having to let go of loyal amazing staff was one of the hardest things I've had to do in my business career.”

But the story does not end there for Pocket Herbs. Australian supermarket chain, Coles came to the rescue with a deal to buy an initial 500 micro herb pots per week to cover 40 Coles supermarkets, then to 101 stores in October with discussions about 200 stores possibly in November.

“When we saw the challenges faced by Pocket Herbs brought about by COVID-19, we were keen to do what we could do to support them. The product they produce is outstanding and we were keen to give our customers something different to add to their cooking,” said Coles Category Manager Andrew Costa.

“It's great that we've been able to stock a fresh Australian product that our customers love and help support a small grower at this difficult time - the herbs are doing really well, and we've received some excellent customer feedback.”

Pocket Herbs initially supplied herbs to 40 Coles supermarkets across Brisbane, Gold Coast, Port Macquaire, the Sunshine Coast and Armadale.

“This has been an amazing outcome for my team and our community. Seeing the industry pull together to support each other has been a real positive during a time of difficulty,” noted Iain.

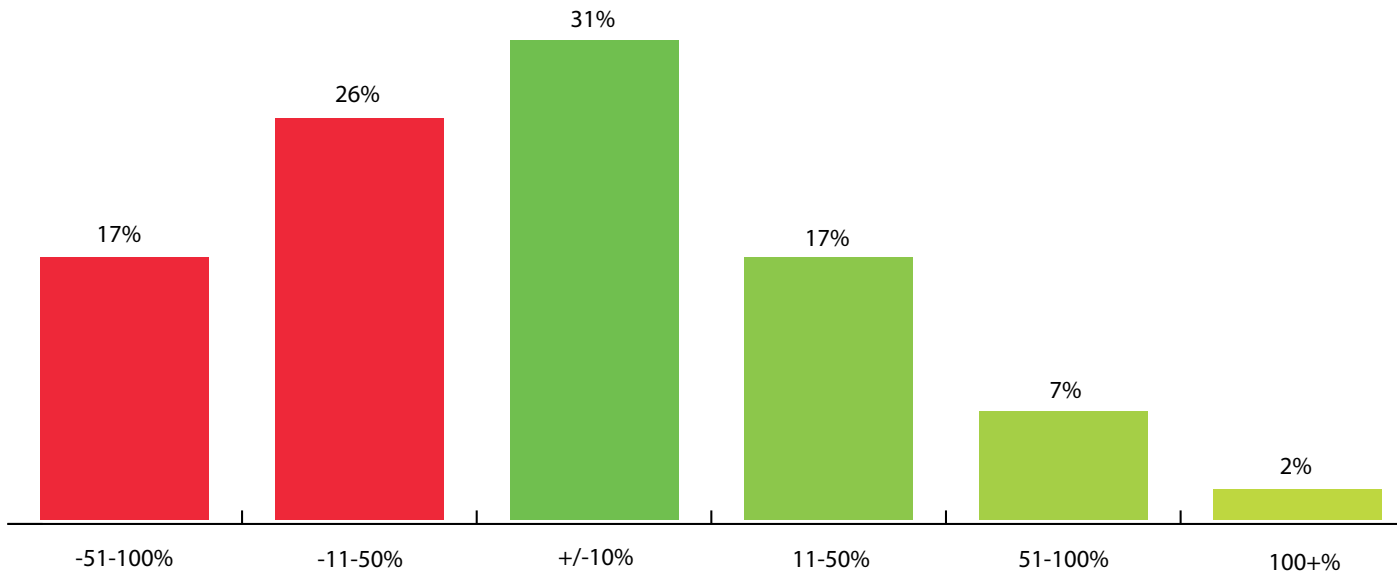
If you would like to learn more about Pocket Herbs visit their website -
<https://www.pocketherbs.com.au/>



The COVID effect on crop sales.

Reported Change in Crop Sales Due to COVID-19

The following analysis looks only at farms founded in 2018 or earlier.



The Census asked respondents to estimate changes in crop sales brought on by the COVID-19 pandemic, and found that, while more farms are down than up, the story isn't too bleak - especially when compared to other reports such as Stone Barns Center for Food and Agriculture's May 2020 report. Overall, 43% of farms indicated that earnings from crop sales are down by more than 10%. Given that restaurants & hotels were the largest customer segment from Census

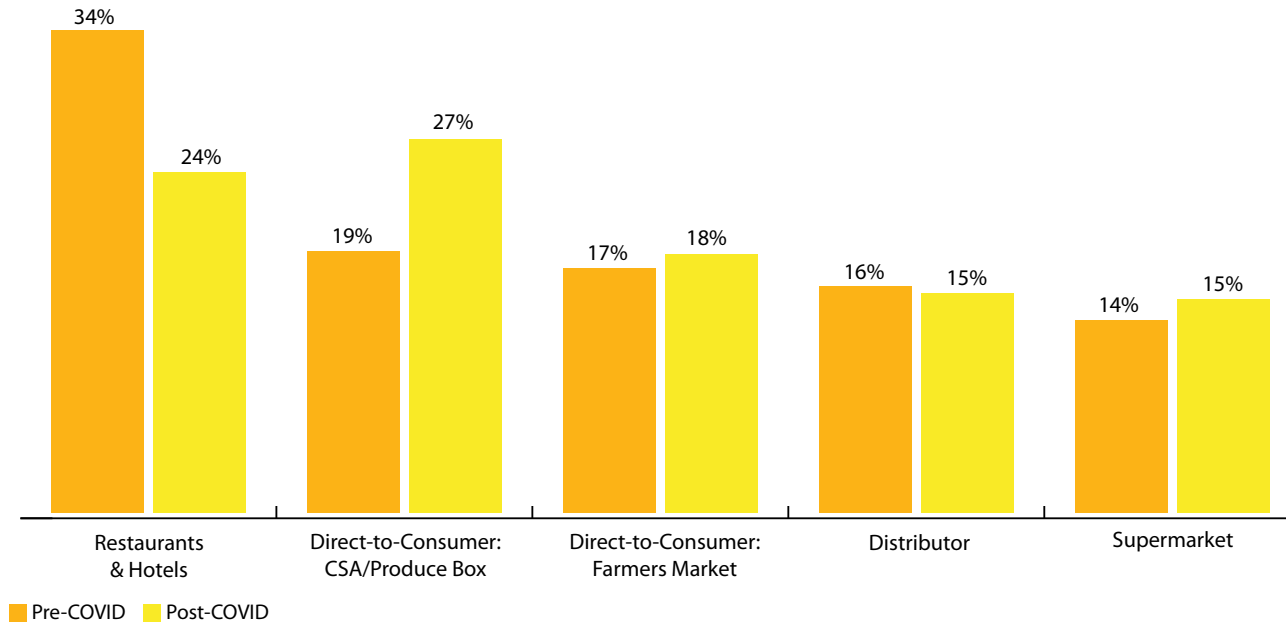
respondents in 2019, it may be surprising that only 43% are seeing a significant revenue loss.

On the other hand, 31% of respondents reported that crop sales are similar (within 10% of pre-COVID sales) despite the post-pandemic hurdles, and 26% have actually experienced a significant increase in crop sales of more than 10%, with 1 in 6 reporting at least a 50% jump.

“26% of respondents reported that crop sales are the same as last year despite COVID interruptions, and 30% claimed sales have increased by anywhere from 11-100+% in 2020 so far as compared to last year.”

The COVID effect on crop sales mix.

Crop sales mix: Pre- vs post-COVID



As anticipated, there was a sizable shift in sales mix away from B2B, particularly Restaurants/Hotels (-10%) and towards B2C models, mainly CSA/Produce Box (+8% pts) as well as a small increase in Farmers Market sales (+1%). Supermarket sales have slightly increased their sales by 1.5%.

To implement these B2C systems, many farms updated their digital presence i.e. website, digital marketing, online stores to attract sales. Of reported solutions to reach new customers during

COVID-19, Website Request Forms and Website Ordering Platforms appeared to provide the most substantial revenue increase. Website Ordering Platforms in particular allowed businesses to shift a much larger percent of their sales mix to CSA/Produce Boxes - from 16% pre-COVID to 32% post-COVID; compared to all others, who saw a more modest increase from 20% to 26%.

“... many farms updated their digital presence i.e. website, digital marketing, online stores to attract sales.”

The COVID effect on other revenue streams.

In addition to crop sales, 47% of established farms featured in the Census contain other supplemental revenue streams that contribute to their overall revenue. Within this group, 61% offer consulting or direct services to other farms. Providing expertise and insights to new operators can be a good way for experienced growers to augment their crop sales, but it can also be difficult to juggle alongside managing the operation itself.

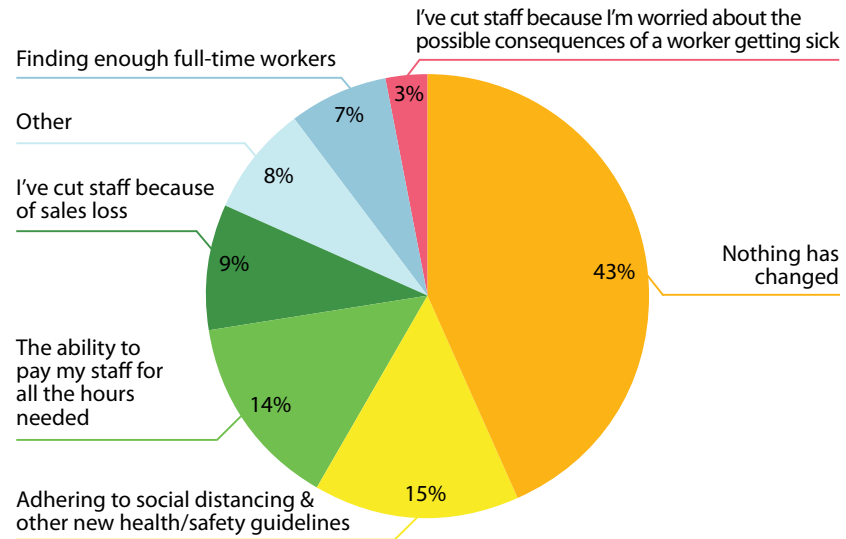
Beyond consulting, 50% of farms with multiple revenue streams earn revenue through education by offering classes or workshops. Education has the added benefit of attracting new customers through word of mouth or referrals, and can be digitally adapted as webinars or virtual sessions. An additional 17% of farms with multiple revenue streams earn revenue through agritourism.

Among farms founded in 2018 or earlier, the impact of COVID on this non-crop revenue category remains mixed, with 35% earning less since the onset of COVID, 33% earning approximately the same amount, and 32% earning more. Perhaps operators that have been able to adapt their consulting, education, and agritourism efforts to the virtual environment have been more successful in retaining this revenue. More details would be required to confirm.

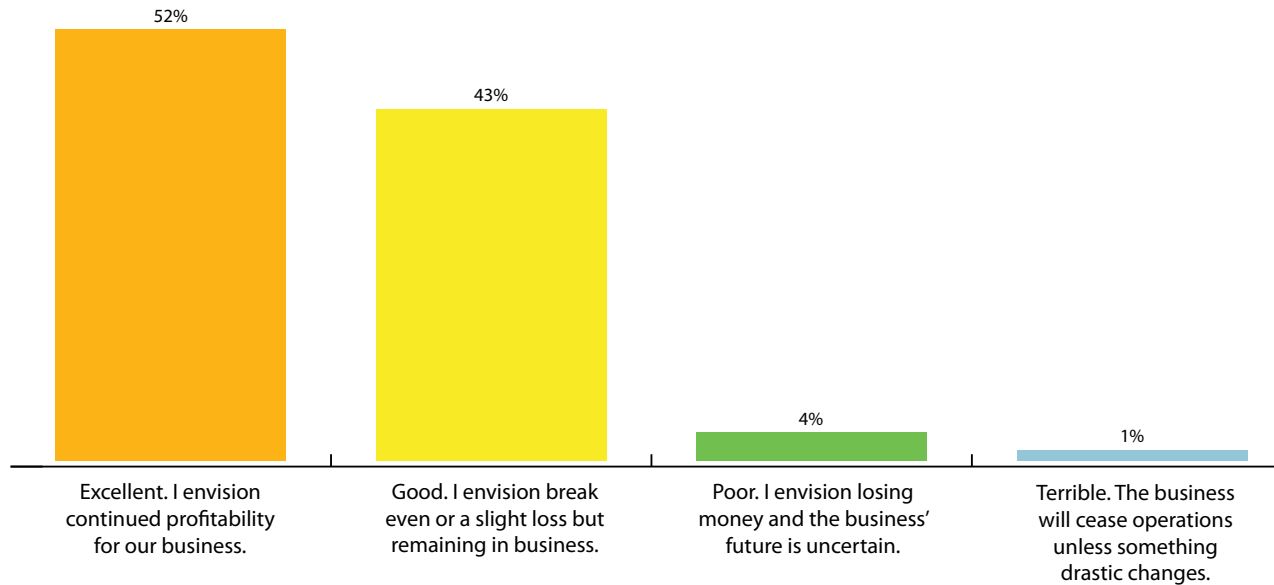
“Beyond consulting, 50% of farms with multiple revenue streams earn revenue through education by offering classes or workshops.”



Biggest challenges related to labor during COVID-19



What are your expectations for your business for the next 12 months of operation?





Spotlight on India.



Namita Gurudas

Business Development Manager,
[AgroTIE](#) Bangalore, India

CEA is growing quickly in India, which was shown through the high number of respondents and recent data in the market. Based on projections related to population growth and socioeconomic status, the likely market for CEA products will be enormous over the next decade. According to projections for 2030, it is estimated that 51% of the population will be classified as either “upper middle” or “high” class, or an estimated 729 million people — that’s almost 10% of the total global population. There are other positive trends as well. The fresh vegetable market in India is expected to grow year over year by 7.6% through 2025. In comparison, the US market for vegetables is only expected to grow by 1.7% per year through this same time period.

At the same time as the consumer market is growing, there is also an added demand for transparency around crop production and processing. According to Namita Gurudas of AgroTie, “It is widely known in India that most greens are grown and washed in wastewater which contains heavy metals- basically unsafe for human consumption. As the awareness of this spread through a video which became viral, more people are being cautious about where they buy local greens and salad greens”.

The government of India is also subsidizing the cost of greenhouse installation for farmers, providing subsidies of up to 50% of the initial cost. This helps the large and mid-sized farmers who focus on commercial production, which is estimated to be approximately 20% of the farming population. CEA operations in India focus on high value crops such as sweet peppers, chile peppers, cherry tomatoes, cucumbers, basil, lettuce and kale. According to Agfunder’s FarmTech Investment Report, India received approximately \$250 million in farmtech related investment in 2019, and ranked 4th internationally, only behind the US, France and Canada in this type of investment.

Bharat Budhiraja

Founder and CEO,
Krish Perennials Private Limited, India



Q. What's your take on how controlled environment farms in your region have responded to the COVID-19 pandemic?

A. Based on the what i've read and through public discussion forums, more controlled environment farms have been built during the pandemic. Not much has been published or talked about their operations and functioning or how they are faring in terms of output and or revenues. In terms of response, I think like most people in the food space, all operators would be sticking to basic hygiene requirements and taking all necessary precautions to avoid the spread of covid to their staff or from their staff to their customers.

Q. What's your outlook on how the CEA industry in your region will fare over the next 12 months?

A. More farms will continue to open and there is momentum in this space with hydroponics becoming the buzz word in India. Not much can be said about the profitability of such farms/ operations as in India, finding the right

market for the produce is not very easy. In order to get a decent ROI, the produce will have to be priced higher than field grown produce and there are not many takers for that at this point in time. In the quality vs quantity debate, quantity continues to win in India even though the customer is more aware now with the rise in diseases like cancer due to overuse of pesticides in fresh produce. So only time will tell what the actual story will be.

Q. What do you feel is the biggest challenge in general to the growth of CEA in your region?

A. Availability of the right target customer willing to pay a premium for produce grown using CEA.

Scalability is not an issue in India, but maintaining the equipment, manpower management, year round consistent availability due to unforeseen hindrances like power availability issues, pest attack, water management issues etc are bigger threats.



Bharat Budhiraja



CHEDDAR
STRAWBERRIES
£2 punnet

Spotlight on the UK.



Mark Horler

Chairman,
UK Urban AgriTech (UKUAT)

Q. What's your take on how controlled environment farms in your region have responded to the COVID-19 pandemic?

A. CEA farms in the UK have, like everywhere, had to adjust very rapidly to COVID-19. For urban CEA farms in particular, many had business models that relied on selling to restaurants and hospitality. They have had to pivot rapidly to other supply chains and revenue streams. An example of this might be switching to a hyperlocal CSA (Community Supported Agriculture) delivery scheme.

Q. What's your outlook on how the CEA industry in your region will fare over the next 12 months?

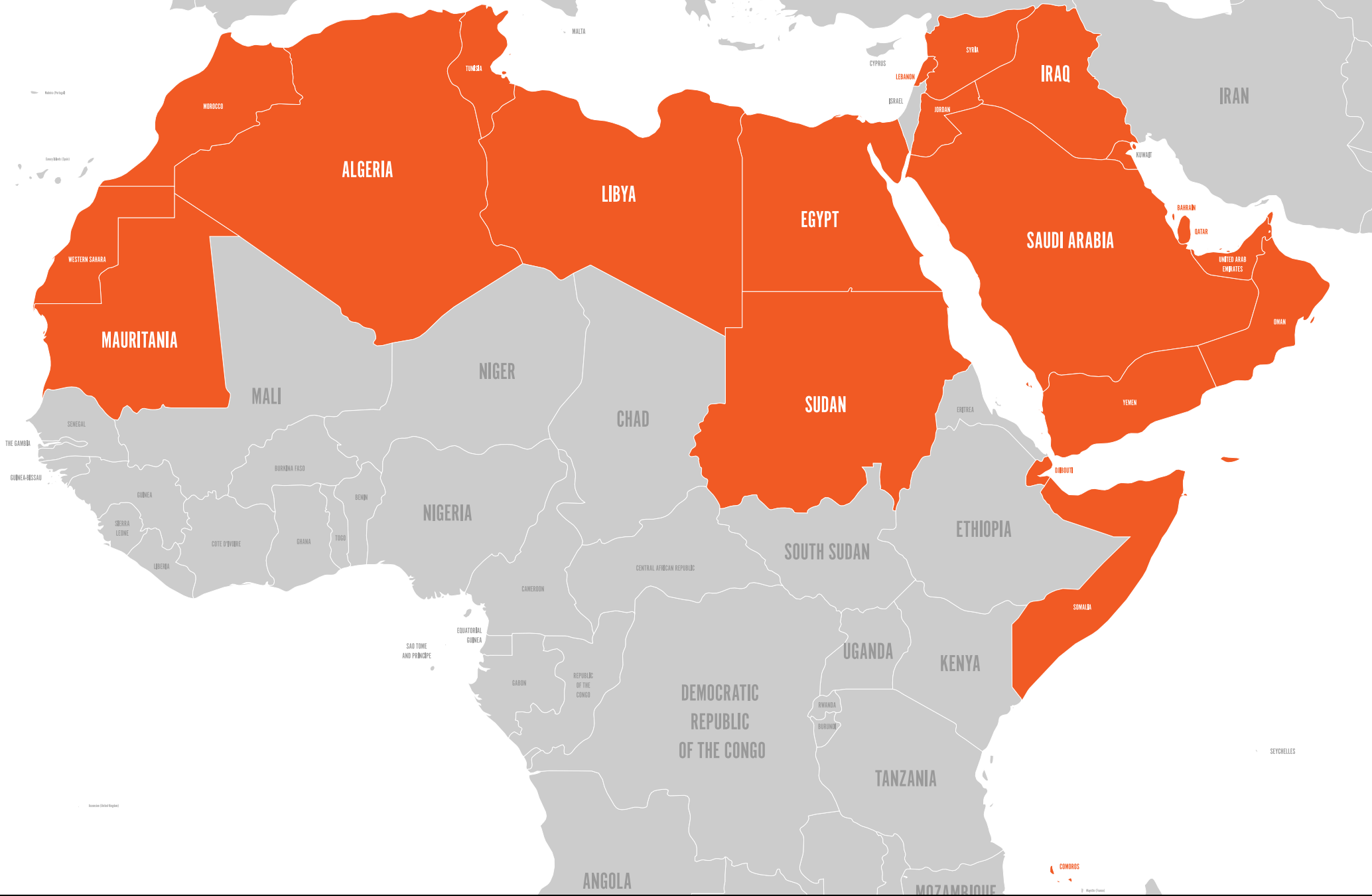
A. This is an interesting period for the UK market. The combination of the pandemic and Brexit is creating an enormous amount of uncertainty. But it is also creating potentially massive opportunities, and a real focus on the need for change in food systems more broadly.

At UKUAT, we're confident that our members from across the industry will be well-positioned and agile enough to take up these opportunities. So though we may see some individual losses and difficulties in the short term, the longer term outlook for the sector is actually very strong.

Q. What do you feel is the biggest challenge in general to the growth of CEA in your region?

A. The big challenges are recognition and standards. Increasing recognition of the benefits of urban agritech - by policy makers, consumers, investors, planners and so on - is necessary to drive demand and the creation of standards. Once these standards are established, the industry will be able to reach the next phase of expansion and interconnection, becoming a strongly rooted part of more sustainable and resilient wider food systems.





Spotlight on MENA (Middle East & North Africa)



Tarik Bushnak

VP of Business Development,
Mishkat, Jeddah, Saudi Arabia



Q. What's your take on how controlled environment farms in your region have responded to the COVID-19 pandemic?

A. Generally speaking, COVID-19 has challenged the global food supply chain. In Saudi Arabia, farms who were utilizing CEA were able to keep up with demand during a period of unusual stress on the local food supply. But they fell prey to the same supply chain issues that more traditional farms suffered from, which was really an issue of logistics and the challenge of transporting their produce between cities during COVID lockdowns. Large scale farms and wholesale distributors who had the logistical muscle and the right government permits were able to move their produce more easily than some CEA farms. The HORECA sector faced challenges due to the lack of tourism revenues and the effect of the COVID lockdown on mobility & consumer habits. But the demand for fresh locally grown produce increased due to the crisis. Consumers also became more price conscious due to the retail cost increase of certain imported goods. CEA farms should take note of this as they move forward and calculate their price pointse.

Q. What's your outlook on how the CEA industry in your region will fare over the next 12 months?

A. On the bright side, there is renewed interest in the CEA sector from the Ministry of Environment, Water and Agriculture and broad support for the growing use of technology in agriculture. The COVID-19 crisis seems to have put the issue of food security back on the national spotlight, and

CEA is well positioned to provide the answer. Vertical farming in particular seems to be on the cusp of having its big moment in Saudi Arabia, but also smart greenhouses like those developed by Pure Harvest are in more demand. I hope that my colleagues in the region can capitalize on this positive attention and create solid success stories that the rest of us can build on in 2021. Right now I'm more optimistic about the future of CEA in the region than I was in 2019.

Q. What do you feel is the biggest challenge in general to the growth of CEA in your region?

A. Despite the general support we have from the government and the growing interest from the private sector, the local infrastructure for CEA is still fragile. We don't have enough local experts or experienced labor force. The agriculture regulations, energy tariffs and operational framework have yet to keep up with the new emerging realities on the ground. For many venture capital firms and local investors, the high barrier to entry to this sector and the long term gains may prove too risky in uncertain times. I believe we in CEA need to make a persuasive case to the stakeholders in the regional food sector (food distributors, local regulators, large scale producers, retailers, agriculture vendors, etc.) that this is the future of agriculture and the sooner we can adopt it the better we will all be. We should promote CEA's strengths- that it's more COVID-proof, and more sustainable than traditional agriculture - while focusing on developing our logistical capabilities and market reach.



Insights: The Future of CEA.

Controlled environment agriculture, just like soil based agriculture, has all types of operations.

There are the micro-farms, which are mostly indoor operations, growing high value crops like herbs and microgreens and selling as locally as possible to command the highest dollar value per pound. Some of these farms also tend to focus on added social or community benefits such as employment of disadvantaged populations or subsidized distribution of their end product.

At the other end of the spectrum are the mega-greenhouse projects, such as the recently launched AppHarvest in Kentucky, 60 acres of tomato production, which will focus on the wholesale market. Many of these farms also seek to have a local impact, but often center it around the broader economic development forces of providing potentially hundreds of new, year-round jobs.

In between we find smaller greenhouses and larger vertical farms, which may focus on local, direct-to-consumer models, a wholesale model, or some hybrid of the two. Questions to consider:

- Which model is more feasible?
- Which one creates more direct impact?
- Which model is the future?
- What factors will influence each model moving forward?

Greenhouses vs Vertical Farms

When we consider the future of CEA, we consider both greenhouse and vertical farm operations.

Greenhouses have three main advantages over vertical farms - free light for a portion of their lighting needs, lower capital expenditures and a larger variety of crops that can be grown feasibly.

Vertical farms' advantages over greenhouses are, generally, the following - stacked production, better climate control, more options for automation and a smaller production footprint requirement.

Of course, there are many other advantages/ disadvantages to each approach depending on an operation's specific location, climate, and market. Questions to consider:

- **Both production systems can be located near their consumer base so what will determine which system marches us into the future?**
- **How much will the carbon footprint of operations influence customer decision making?**
- **Is automation and job displacement a factor that could influence consumer decisions?**



Mini versus Mega

- **Will the future of CEA be mini or mega farms or something in the middle?**

Mini farms are more suited to urban locations, making use of underutilized spaces and a direct-to-consumer customer base.

- **But, can they be economically viable on such a small scale?**

Traditionally, operating costs in cities, especially rent, have been a challenge to overcome, but the COVID pandemic has resulted in many people working virtually, businesses and residents vacating cities and cheaper leases for urban farmers.

- **Will this change be permanent?**

On the other hand, mega farms have the advantage of scale, operating efficiencies and the ability to implement automation in all areas of production. We also have to consider the established distribution system of a location.

- **Does the farm model fit with the existing distribution model and if not, will a new distribution model also need to be established for the farm to thrive?**

Access to capital could be a determining factor. Only in the last three years have we really seen it become more common for CEA companies to raise hundreds of millions of dollars from private investors.

If these investments in companies such as Plenty, AeroFarms, Bowery, and AppHarvest show strong ROIs, we will see a lot more investors ready to write big checks like this. The flip side of this could mean a similar “go big or get out” mantra that has become the norm in conventional agriculture, also becomes the norm in the CEA space, because economies of scale will rule once more.

On the other hand, access to capital is also becoming more democratized. It was only in 2016 that equity crowdfunding became effectively legalized in the US through the SEC’s adoption of rules related to the 2012 JOBS Act.

While still small, the market is growing fast - up 59% YoY from 2018-2019. And equity crowdfunding is just one example of the broader alternative financing movement that includes CDFIs - a banking alternative focused on local community development which has grown from a \$4b market prior to 2000 to a \$136b market in 2017.



However it plays out, one of the most compelling takeaways we're left with from this year's Census is the overwhelming feeling of optimism across all farms, with nearly 95% reporting "excellent" or "good" expectations for the next 12 months - versus just 5% reporting "poor" or "terrible" expectations - defined as "business future uncertain" or "business will cease operations unless something drastic changes".

"At Agritecture, we believe that decentralized capital is a major key to unlocking more opportunity for small- to medium-scale, but still commercially-viable and highly-impactful, farming businesses. It's one of the major reasons that we're in the midst of partnering with several alternative financing vehicles through our Agritecture Designer platform." Henry Gordon-Smith, Managing Director Agritecture.

Transparency for Consumers

Large operations across all sectors can struggle with losing their identity (in the eyes of their customers) and the unique attributes that won over their customer's hearts in the first place.

Product transparency is an ever more important factor for consumers when making product choices.

Small operators have more ability to make a direct connection with consumers and gain their trust.

95% reporting "excellent" or "good" expectations for the next 12 months

Larger operations have the benefit of economies of scale that can allow for more competitive prices, larger marketing budgets, and stronger social media presences, but they may have to work harder as large businesses to create the same authentic consumer connection. "Know your farmer, know your food" is a popular bumper sticker among those who support farmer's markets, but is this personal connection as important anymore with social media becoming so prominent in our lives?

Large farms serving many markets can't match this connection, but they can build trust via social media and compete more on price points with competitive, conventionally-grown products, and those two factors may be good enough for their target customers.



What about home systems?

The pandemic has proven to be a boon for home gardening and home hydroponic systems are not an exception. There are many reasons that one could be motivated to produce food at home.

These include: improved food security, improved food independence, improved food freshness & nutrition levels. Questions to consider:

- **How long will the pandemic last and will this rationale continue post-pandemic?**
- **Are more people producing food at home simply because they have more time on their hands?**

For urban residents, without large tracts of land available, it is unrealistic to imagine producing large volumes of food, but small production systems for herbs and leafy greens could become widespread.

“As the climate continues to change, our standard means of food production will face ongoing pressure to produce consistent, clean, and affordable produce. What once seemed easy and cheap, will become expensive and difficult.

CEA presents a new paradigm of adaptable agriculture for a climate insecure future where food can be grown closer to consumers using less water, nutrients and pesticides. Driven by local market conditions and global climate shifts, I predict CEA will be a meaningful source of

fresh produce in regions across North America, Northern Europe, the GCC, and SouthEast Asia in the next decade.

I think that in those regions where demand for fresh produce is significant, large scale operators will be the most successful, especially when matched with low cost, abundant energy. Dense urban environments and newly planned communities will be ripe for small and medium scale CEA operators that can connect with consumers directly, create unique experiences, and be part of the green infrastructure of 21st century cities.” Henry Gordon-Smith, Managing Director, Agritecture.



The Future Workforce

One of the underlying impacts on the various models noted above will be who is growing our food and the level of experience that workforce brings.

“To look at the future we need to consider who that workforce will be and what their goals are now. Consider that by 2026, there will be 82 million Gen-Z in the U.S. alone, making them the largest consumer generation in American history. Around the world it will be these generations who will be growing our food and will expect technology and other infrastructure to reflect their needs and experience.” Darryn Keiller, CEO, Autogrow.

With a fast growing generation whose reliance and use of technology is prolific, CEA will be required to evolve and adapt.

The industry as a whole will need to consider how to attract more young people and ensure we have a suitably trained workforce to provide for the increase food production necessary for the growing population.





Acknowledgements

We'd like to again thank all the farmers who shared their knowledge and expertise to take part in this Census. From our perspective it is an incredibly valuable process that has garnered information we will all be able to learn from.

We also recognize the additional research we have cited through our report which has helped to give context to our Census.

We'd also like to acknowledge the work of the Autogrow team - Kylie Horomia and Debs Abraham, and Agritecture team - David Ceaser, Ricky Stephens, Briana Zagami, Maggie Drew and Bea Minana.

Our industry is on the precipice of significant change which makes for an exciting place to be.

Any queries or comments regarding the Census please contact david@agritecture.com or kylie.horomia@autogrow.com

www.autogrow.com

www.agritecture.com



A Few Words From Our Authors.

Find the hidden microclimates that are affecting your crops

Lack of comprehensive climate information is costing you

You witness the effect of microclimates on your crop quality and yield each day but you can't pinpoint their location. You know them to be potential sites of disease outbreaks but you're powerless to act. You have a limited view of climate across your growing area and it's costing you. If you had a way to identify the microclimates that impact your plants, wouldn't that help?

At last, a richer view of your climate

Folium is a wireless climate monitoring solution that delivers multiple climate readings from multiple locations in your growing environment. Armed with this richer data you can quickly identify and manage problematic microclimates to optimize crop yield and minimize crop loss from pests and diseases.

Designed with the grower in mind

Folium measures temperature, relative humidity, CO₂, PAR, RAD, and barometric pressure and displays readings as heatmaps, graphs or tables. It also alerts you when your climate falls outside set parameters. Deployed as a network of units to cover large commercial growing areas your data is accessible on any device, from anywhere at any time.



Folium displays climate data as real time heatmaps, graphs or tables and sends alerts when readings fall outside set parameters.

“Our current sensors are above the canopy but with Folium, we hang them between the crop and check the plant humidity levels.”

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- Soil/substrate moisture

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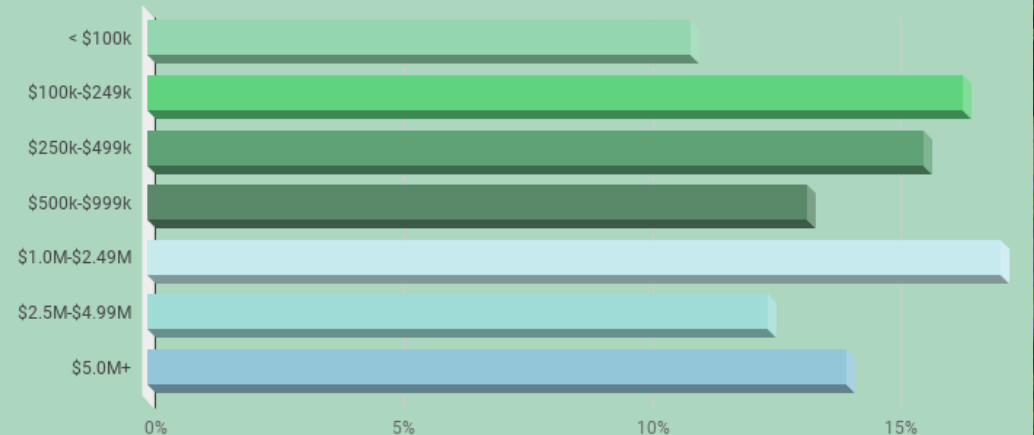
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"This tool has been a life saver. It guided me step by step from choosing a crop to avoiding common mistakes." - Al Namaan, Oman

"The quickest and best way I know of to get a crash-course in urban farming" - Charlie, London, UK

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