RECIRCULATING FARMS

# AQUAPONIC FARMS IN THE U.S.

2022

# ACKNOWLEDGMENTS

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# EXECUTIVE SUMMARY

This report, **Aquaponic Farms in the U.S.**, illustrates the viability of growing plants and raising fish together in a related agricultural system and provides a roadmap to advance the expanding practice of aquaponics. By identifying and addressing opportunities and challenges, these land-based, often recirculating farms can thrive, while providing more local food and using fewer resources nation-wide.

In collaboration with Recirculating Farms, Auburn University developed and distributed a survey for aquaponic operations.[1] The results were analyzed to develop a first hand, comprehensive understanding of the overall structures, operations, markets, economics, successes, and challenges in this industry.

Aquaponics are water-based growing systems that use continually cleaned, often recycled water as a means to grow a wide range of plants and fish, for various uses, including food for local communities. Aquaponics can conserve water and energy, have low food safety risks, produce large amounts of fish and plants in small spaces, and pose low environmental impacts, while providing fresh, local food.

Various towns and cities across the United States are creating local ordinances to support the development of this industry. This is no longer just a backyard hobby, and is becoming a meaningful opportunity for food security and economic growth nationwide. Of those surveyed, nearly 25% of the farms are in urban environments, 16% in suburban settings, 55% in rural areas, and nearly 2% are in industrial zones. Not every respondent indicated their location.

Aquaponic farms produce both plants and fish, but vegetables often have the largest popularity in the market. Currently, training and education are areas for growth opportunities, especially since the practice does not have sufficient external support. Often farmers teach each other, which is similar to other undervalued emerging industries. For example, in the early 1980s, organic farmers created learning circles, since state and federal support was initially limited. Workforce development provides great potential for this field.

Aquaponic farms provide economic growth for farm team salaries, and owners' income, when the operations are profitable, and growth for the industry as a whole, even during developing stages, with equipment purchases, design, and consultations. Based on our survey, among profitable farms, the average annual revenue from plant production is $483,585, while fish production nets $77,000. Additionally, revenue from equipment, supplies, and services averages $42,857, annually.

Initial start-up costs can be daunting, depending on scale and design, and in some cases near fatal for some entrepreneurs, as infrastructure and building costs can be a high hurdle. The survey showed that the average building cost is $74,277 with the highest being $600,000, most of which was financed with personal funds. Start-up investments can provide aquaponic farms with the necessary help to be efficient, productive, and sustainable. Starting small and scaling up over time, can keep costs manageable. Fourteen respondents reported that their operations were profitable.

Some of the biggest challenges for aquaponic producers are systems management and design. This consists of maintaining environmental controls, such as water pH and temperature, level of humidity, ratio of fish to plants, and equipment upkeep. Additionally, there is a general lack of information and resources on aquaponic systems, whether that be educational support, or materials for the system itself. A lack of skilled workers was another difficulty noted by aquaponic entrepreneurs.

In terms of regulatory roadblocks, local, state, and federal regulations create barriers for selling produce and fish. Specifically, sales permits, food processing, and safety requirements can make it impossible to achieve economic profit in less than very large scale operations. Permits and licenses associated with fish species, especially non-native fish, were another challenge. These are surmountable issues if the state and federal governments commit to lifting up recirculating farms and work with growers to set requirements that are both meaningful and attainable. This is an industry that merits support and expansion.

Specifically, **we recommend** the following:

1. States and local governments should collaborate with experienced operators to develop specific permitting standards and checklists, readily accessible for aquaponic entrepreneurs to better understand permitting requirements and processes, and reduce barriers to entry;
2. Aquaponic farmers and aquaponic organizations should collectively create regional practice guides to support ongoing industry development;
3. Government entities should recognize and support aquaponics as an expanding and sustainable form of agriculture, and assist in promoting aquaponic farms, farmers, and products in the market;
4. Government entities should highlight sustainable and innovative agriculture, by including aquaponics on websites and in other media; and,
5. Government entities should offer aquaponic growers the same access to support and tools provided to other farmers, including government grants, equipment, insurance and other assistance.

## General Term Definitions

***Hydroponics.*** The process of growing plants in nutrient-filled liquid in a medium other than soil (such as gravel, clay pellets, etc.).

***Aquaponics.*** The process of growing plants and raising fish in a symbiotic environment, where fish waste provides nutrients for the plants, and the plants, in turn, keep water clean for the fish.

***Aquaculture.*** Raising finfish, crustaceans, mollusks, aquatic plants, algae, and other aquatic organisms in a controlled environment (both freshwater and saltwater). Also, known as fish farming.

***Land-based aquaculture.*** Aquaculture that occurs in on-land facilities, as opposed to natural oceans, lakes, or rivers (for example, inside warehouses in tanks, or outdoor created ponds).

***Recirculating farming.*** A method of agriculture where continually cleaned, recycled water is used as the basis to grow plants and/or other aquatic species (like finfish). Recirculating farms can be hydroponic (just plants), aquaculture (just fish), or aquaponic (fish and plants together).

**Hollygrove Market and Farm in New Orleans, LA**

# I. INTRODUCTION

Aquaponic systems combine aquaculture (raising fish) with hydroponics (growing plants in a nutrient-rich liquid medium) in a symbiotic environment. In this type of system, the waste produced by farmed finfish, or other aquatic species, supplies nutrients for plants grown hydroponically, which, in absorbing the nutrients, in turn purify the water.[2] There are unique environmental, social, and economic benefits associated with aquaponic systems. Overall, they reuse water, recycle waste, use less space to grow more food, and can incorporate renewable energy strategies.

Recirculating aquaponic farms are those that grow food and other plants (including ornamental), with the use of continually cleaned, recycled water. Grow systems can be designed in many ways, using a range of styles and methods.

In “aeroponic” models, plants are held in a structure that allows plant roots to be exposed to the air, rather than buried in a medium, and they are fed regularly with nutrient-rich water. Common examples include grow towers. Many farms use container growing, with assorted mediums to stabilize plants, including lava rock, pea gravel, pumice stones, and other similar substrates. Other common popular approaches are deep water culture, in which plants float on mats atop a water filled pond and Nutrient Film Technique (NFT). Recirculating aquaponic farms can be many shapes and sizes, based on a growers ability and creativity.

**Grow Towers**

**Raised Grow Bed**

**Plants Float on Mats Atop a Water Filled Pond**

**Nutrient Film Technique (NFT)**

These farms can grow a diversity of both plants and fish and there are many unique benefits associated with aquaponics:

- These are mostly closed-loop, land-based farms that are able to reuse water and can recycle waste.
- Well-designed farms can run without antibiotics or other chemicals, and use renewable energy.
- Recirculating farms can grow fish along with vegetables, flowers, fruits, herbs, and more.
- They do not need to be connected to any natural waters, and can therefore, grow a wide range of products without the threat of releasing them into the wild, or creating competition with fishermen who make their living selling popular local fish.
- Recirculating farms are scalable: they can be as compact as a desktop for personal use or larger for commercial operation.
- Being contained, and therefore cleaner, allows these farms to be located near markets and in communities far from water that will ultimately use the products.
- Having more farms in each community cuts down on use of fuel for packing, transport, and refrigeration, and provides consumers with fresh, local food.

Some operations that use antibiotics and chemicals, often do so at a notably reduced rate than those typically associated with other forms of aquaculture. Any inputs are approved by the Food and Drug Administration (FDA) and/or the US Department of Agriculture (USDA) for animal husbandry or other organic substrates. Since it is an entirely contained system, there is less threat of harm to natural ecosystems. Furthermore, the diversity of fish raised do not compete with local fishing communities.[3]

Aquaponic systems are well suited for urban areas since they can be established in abandoned industrial buildings, thus utilizing spaces less likely to be used for residential purposes. They can also be located in awkwardly shaped, small, rocky or paved spaces, unsuitable for traditional agriculture in cities, as they can be designed vertically, creating more opportunity for local food. They create shorter supply chains, generate jobs, decrease transport cycles, reduce the need for refrigeration and lower storage costs.[4] All of this is important for increased urban food security, local economics, and addressing challenges - like overuse of fossil fuels - associated with a changing climate. Aquaponic systems utilize gas and electricity for heat and light, but by incorporating clean energy, the systems could be fully sustainable and self-sufficient.

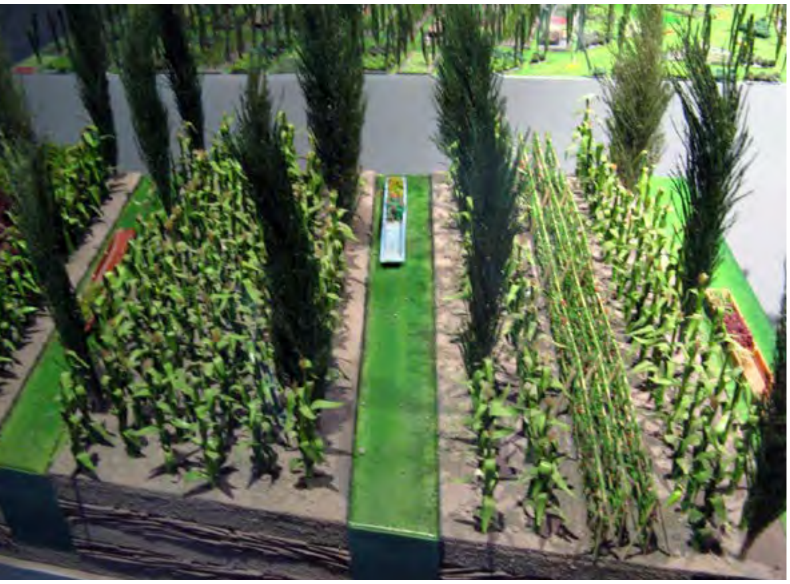
## *How Do Aquaponic Systems Work?*

Aquaponic systems are a combination of recirculating aquaculture (raising fish) that incorporate the production of plants (hydroponics). Recirculating systems are designed to raise large quantities of fish in recirculated water. In the process of reusing the water many times, non-toxic nutrients and organic matter accumulate. These metabolic by-products support the growth of marketable secondary crops - a variety of plants - and can also benefit the primary fish production system. Systems that grow secondary crops (plants) by utilizing by-products from the production of the primary focus (fish) are referred to as integrated systems. If the secondary crops are aquatic or terrestrial plants grown in conjunction with fish, this integrated system is referred to as an aquaponic system.[5] In some instances, the plants are the primary crop and the fish are simply the means to provide regular, natural materials for healthy plant growth.

There are a few general principles of aquaponic systems. The first is to use any nutrients in the system as efficiently as possible, benefitting the production of both fish and plants. The waste produced by fish is a main source of nutrients for plants in aquaponic systems, made available for uptake by microflora, also present in the system. Though fish waste contains many necessary nutrients, others may be needed, such as iron or other vitamins to ensure proper plant growth.[6] The ideal feeding rate for aquaponic systems varies, based on the fish and plants cultivated.

A main component of all aquaponic systems is the effective use of the water in the system, with the purpose of optimizing growth of fish and plants. Based on water flow, systems can be divided in two groups: coupled and decoupled. Decoupled systems transfer the water containing fish waste from the fish tank to the plants, without recirculating back to the fish. Coupled, or fully recirculating systems, recycle the water completely, with full water transfer from fish tanks to plant tanks and back to fish tanks.[7]

The materials and design of the system ensure the nutrients and water can be recycled, unlike most other aquaculture systems, such as those that use earthen ponds. Common fish tank materials include plastic, fiberglass, and concrete. Most existing aquaponic systems are located within structures that have a level of environmental control, such as greenhouses. This environmental control can improve the productivity rate of the plants and fish.[8] However, it also often requires the use of more energy.



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## History of Aquaponics

Aquaponics is an ancient practice. These systems are believed to have originated in what is present day China, and were also used by Aztecs, Egyptians, Japanese, Peruvians, and Greeks. Research indicates that the famous Hanging Gardens of Babylon were hydroponic in nature, and perhaps even aquaponic. Similarly, the chinampas of the Aztecs, were traditional aquaponic systems, feeding the majority of the people of the city of Tenochtitlán. The practice provided communities with food security as populations grew.[9]

In the United States, aquaponics has been expanding in popularity and practice for decades, refining techniques and methods to increase production, profitability, and environmental sustainability. Academic, government, and business facilities across the country are conducting research and implementing new ways to further improve and expand these farms. In the early 1980's, a lead researcher, James Rakocy, and his team at the University of the Virgin Islands (UVI) began reviewing the viability of aquaponic systems.[10] Over the years, the UVI Aquaculture Program developed a low-cost commercial-scale aquaponic system that now produces 5 metric tons (MT) of tilapia annually and a variety of vegetables. The research from this facility has been used by many to demonstrate that aquaponics can be an economically viable system of aqua-agriculture in almost any climate and conditions.[11]

## Current State of Aquaponics in the United States

Today, commercial aquaponics production exists primarily in controlled environments, such as greenhouses, or in outdoor locations in warm climates, using methods and equipment that draw from both the hydroponic and aquaculture disciplines.[12]

In 2013, researchers conducted one of the first large-scale surveys of aquaponics practitioners, and found a rapidly growing field in which gardeners were the largest group of respondents, as this was still considered an experimental type of sustainable farming, rather than an accepted, viable business. Some systems have significantly higher annual costs compared to in-ground and raised soil-bed gardens, if they are completely inside and scaled-up.[13] The USDA's 2018 Census of Aquaculture found 82 aquaponics farms across 25 states, a 15.5% increase from the 2013 Census. Sixty-eight percent of farms were valued less than $25,000.

Over time, the systems have become more efficient with greater economic potential. Currently, there is expanding interest in aquaponics as a form of sustainable agriculture that can be used to produce food closer to urban centers, enhance food security, shorten supply chains, and provide opportunities for economic development.[14]

# II. LAW AND POLICY

## *Local Ordinances for Aquaponic and Hydroponic Systems*

City Councils in several cities, including Los Angeles, New York City, and Chicago, have passed local ordinances to support and manage urban farming and innovative agriculture systems, such as aquaponics and hydroponics. These Ordinances can greatly impact the viability of aquaponic operations and urban food security.

In Los Angeles, Ordinance 185022 implements the Urban Agriculture Incentive Zone program, which promotes urban agriculture in exchange for reduced property tax assessments. Ordinance 182475 designates a specific land area for agricultural use within city limits, including aquaculture and hydroponic operations.

In New York City, Section 4-208 states that all city properties must be identified as potentially suitable for urban agriculture. City zoning allows agriculture in all residential zoning districts and the majority of commercial zoning districts. Agriculture is also allowed in all manufacturing zoning districts. Farms and gardens in residential districts are not permitted to sell produce from *other* sites in addition to the produce grown onsite. This restriction does not apply to commercial and manufacturing zoning districts. Rooftop greenhouses are allowed in New York as well, with a certification from the Chair of the City Planning Commission. These greenhouses must be located on buildings without residences, used for the cultivation of plants, less than 25 feet in height, mostly transparent, and set back from the perimeter wall by six feet if the greenhouse exceeds the building height limit in the district.

In Title 17 of the Chicago Zoning Ordinance, urban farms are separated into three types of operations: indoor (greenhouses, vertical farming, hydroponics and aquaponics), outdoor (growing beds, growing fields, hoop houses and orchards), and rooftop (growing beds and growing trays on rooftops). Indoor operations are allowed in Public and Civic Zoning Districts. The requirements consist of building permits, zoning approvals, relevant business licenses, and off street parking for employees. Every applicant must identify all licenses or permits that are required. Farms cannot use food scraps or landscape waste. They can sell compost material generated onsite, but must comply with regulations in 7-28-75 of the Chicago Municipal Code.

## *Organic Regulation for Aquaponics*

The National Organic Program (NOP) established a Hydroponic/Aquaponic Task Force in 2015 to craft a report for the National Organic Standards Board (NOSB) on whether hydroponic/aquaponic should be allowed under current NOSB regulations; and if not, how the regulations could (or should) be changed. This was the first such report and survey since 2010. A significant finding was that the 2010 survey noted only eight organic certifiers certifying hydroponic operations as organic, and only 39 hydroponic growers. The survey applied in 2016 found that there were 52 certified organic hydroponic/aquaponic operations in the United States, and 69 certified operations that grow crops in containers. That is an "88% increase in certifiers who certify hydroponic and aquaponic operations."[15]

The Crops Subcommittee Proposal advocated for the development of more specific rules defining organic certification for hydroponic and aquaponic systems. The Subcommittee recommended further research for container-based systems. They argued that hydroponic and aquaponic production systems are rightly eligible for organic certification, since the farms conserve incredible amounts of water, dramatically reduce food safety risks, and pose low environmental impacts. Hydroponic and aquaponic operations can be certified organic for plants only (not the fish), as long as the certifier can demonstrate compliance with organic standards.

# III. METHODOLOGY

## A. Survey Instrument

Recirculating Farms Coalition, in collaboration with Auburn University, with input from the Center for a Livable Future at Johns Hopkins, created a survey for aquaponic hobbyists, educators, and producers. The full survey can be found in Appendix 1. Seventy-nine questions spanned across 9 sections, as follows:

- Introduction, including overall operations
- Hobbyist Focused
- Fish Production
- Plant Production
- Marketing
- Economics/Commercial Business
- Food Safety
- Demographics
- Conclusion

## B. Sample, Data Collection & Limitations

The survey was emailed to a variety of aquaponic operations through organizations, institutions, and private businesses. Some questions were not applicable to all operations; therefore, not all respondents answered every question. The survey opened in December 2019 and closed in June 2020.

The geographical range was determined by identifying the IP addresses, as individual data was not collected for proprietary purposes.

The inclusion criteria for the study included the following parameters:

- Is an aquaponics practitioner based in the United States

- Answered greater than 50% of the questionnaire, and,
- Actively farms and sells aquaponics products

A total of 534 survey responses were collected. Three rounds of an elimination process were applied, as illustrated below. Exclusion Round 3 resulted in 101 operations, which have been evaluated for overall operations. An additional Exclusion Round 4 resulted in 14 respondents who indicated their operations were profitable. Their responses were applied to the profit-driven analysis.

**SURVEY RESPONSES**

**n=534** **Initial Data Set**

**n=305** **Exclusion Round 1:**
Removed respondents who stated they were outside of the United States, not currently in operation (nor previously in operation), not currently selling products.

**n=224** **Exclusion Round 2:**
Removed respondents who answered less than 50% of the survey, who did not respond to the question on if they sold products.

**n=101** **Exclusion Round 3:**
Removed respondents with longitudinal / latitudinal data and IP addresses outside of the United States, removed respondents who stated they were in design or construction phases (not Currently in Operation).

## C. Data Reporting and Analysis

The data are represented in 19 charts, pies, and tables (figures). The sample size (n) is reflected in all figures, plus the tables include the mean (average), median (mid-point), and standard variation (margin of error). The results focus on Operations, Production, Economics & Markets, and Challenges.

# IV. SURVEY FINDINGS

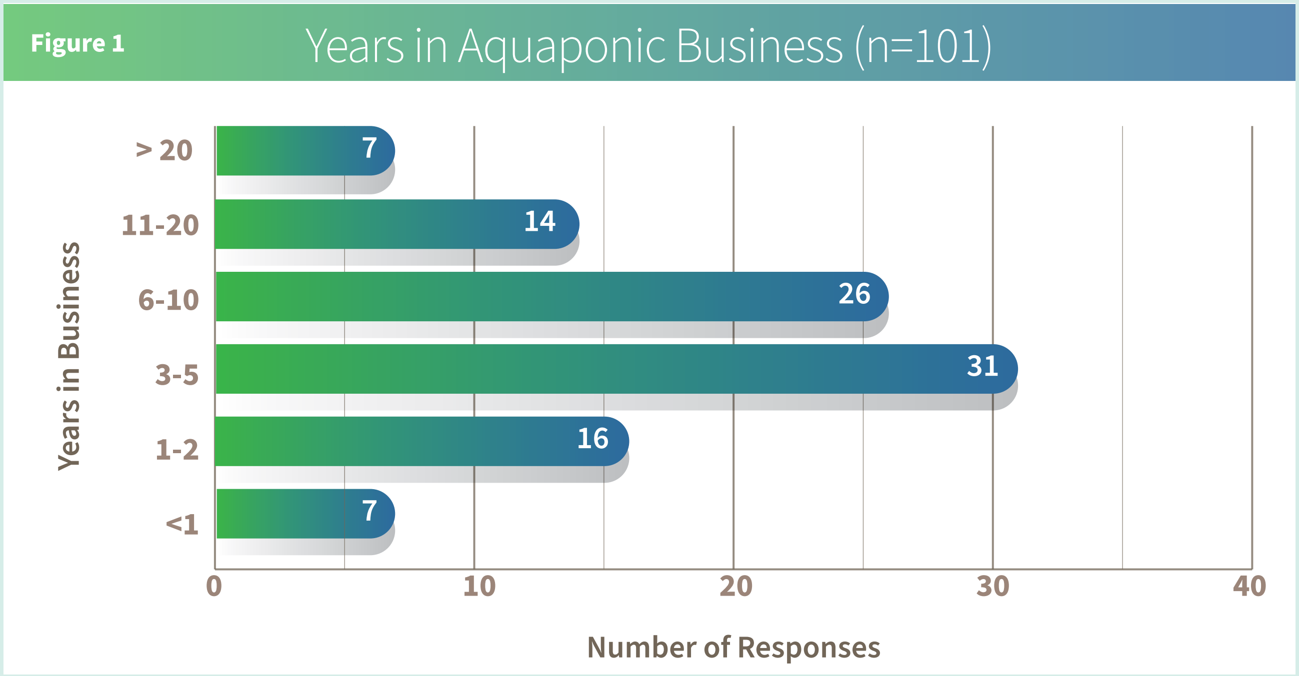
The survey findings provide insight to the products produced, types of operations, economic statistics, roadblocks, and areas of support to enhance this growing industry. These findings provide an understanding and background of aquaponics in the United States to provide legislative, regulatory, financial, and educational support.

## A. Operations

Internal operations and operational structures provide an overview of the basic elements for existing aquaponics businesses. Operations offer a snapshot of the viability of aquaponic farms for economic and product potential across the United States in different settings.

## Figure 1. Years in Aquaponic Business (n=101)

- The majority of survey respondents have participated in aquaponics operations for 3-5 years, followed by respondents with 6-10 years of experience.
- The 3-5 year period is crucial to ensure these operations have longevity to benefit food and economic systems.



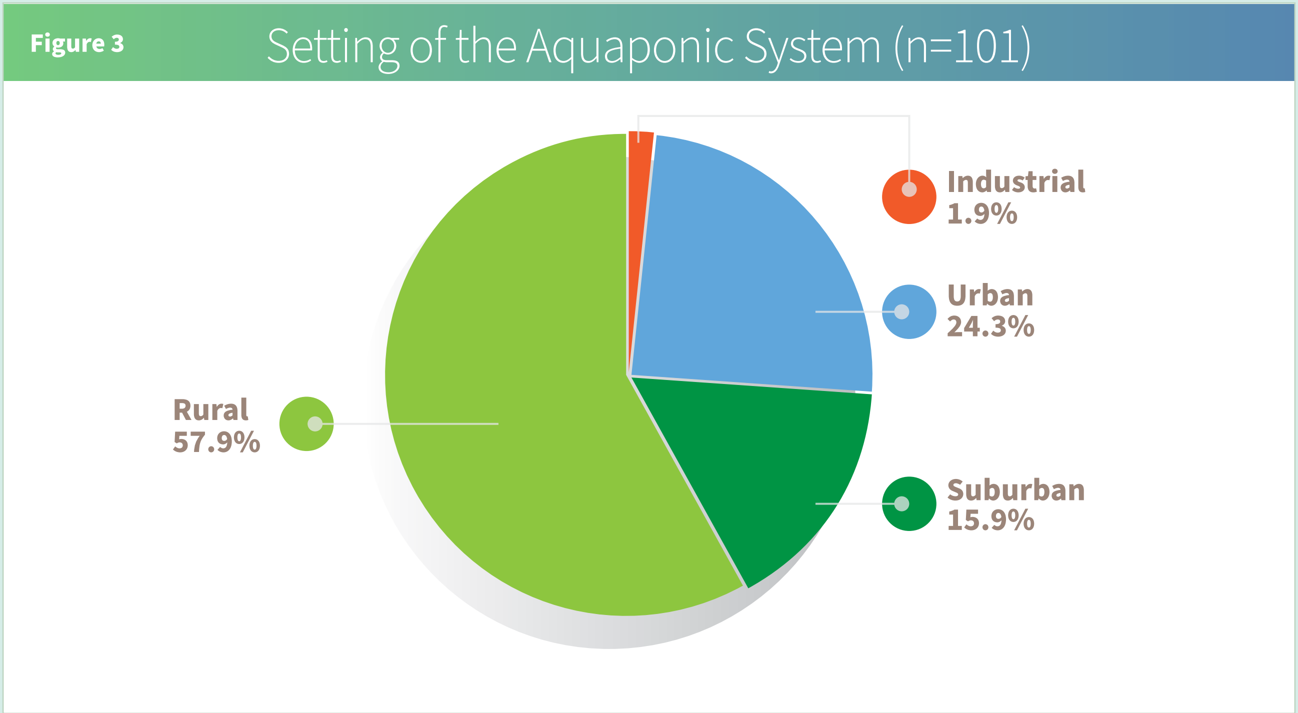

## Figure 2. Number of Employees at Aquaponic Production Farms (n=29)

- There is a variation in staffing, ranging from 0 employees to 50 full time employees.
- Farm owners do not count themselves as employees and many operate without any additional assistance.

| Employees | Minimum | Maximum | Median | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Full Time | 0 | 50 | 1 | 6 | 11.8 |
| Part Time | 0 | 40 | 0 | 3. | 8.11 |
| Seasonal | 0 | 4 | 0 | 0.17 | 0.76 |
| Unpaid/Family Volunteers | 0 | 100 | 0 | 4.2 | 0.77 |

### Figure 3. Setting of the Aquaponic System (n=101)

- The majority of the aquaponic systems are located in rural areas.
- Currently, nearly 25% are located in urban environments.
- Industrial settings could be rural, urban, or suburban.



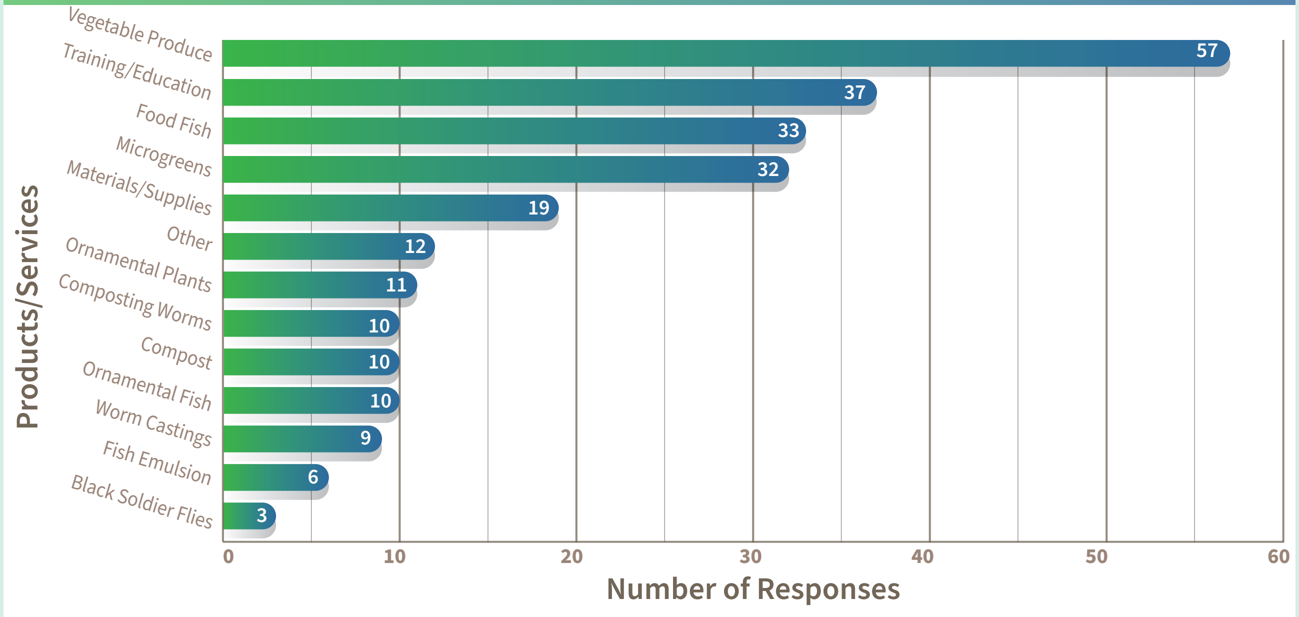

## B. Production

Overall, based on findings from the survey, the four most commonly sold aquaponics products and services are produce, training & education, food fish, and microgreens. There are some secondary products related to aquaponic operations, such as black soldier flies and fish emulsion.

### Figure 4. Overall Aquaponic Products and Services Sold (n=79)

- Not all sales produced a net profit for the operation.
- Vegetables are the principal product sold.
- Training and education opportunities were significant financial assets.
- Although 79 respondents sell their products, only 14 reported a profit.

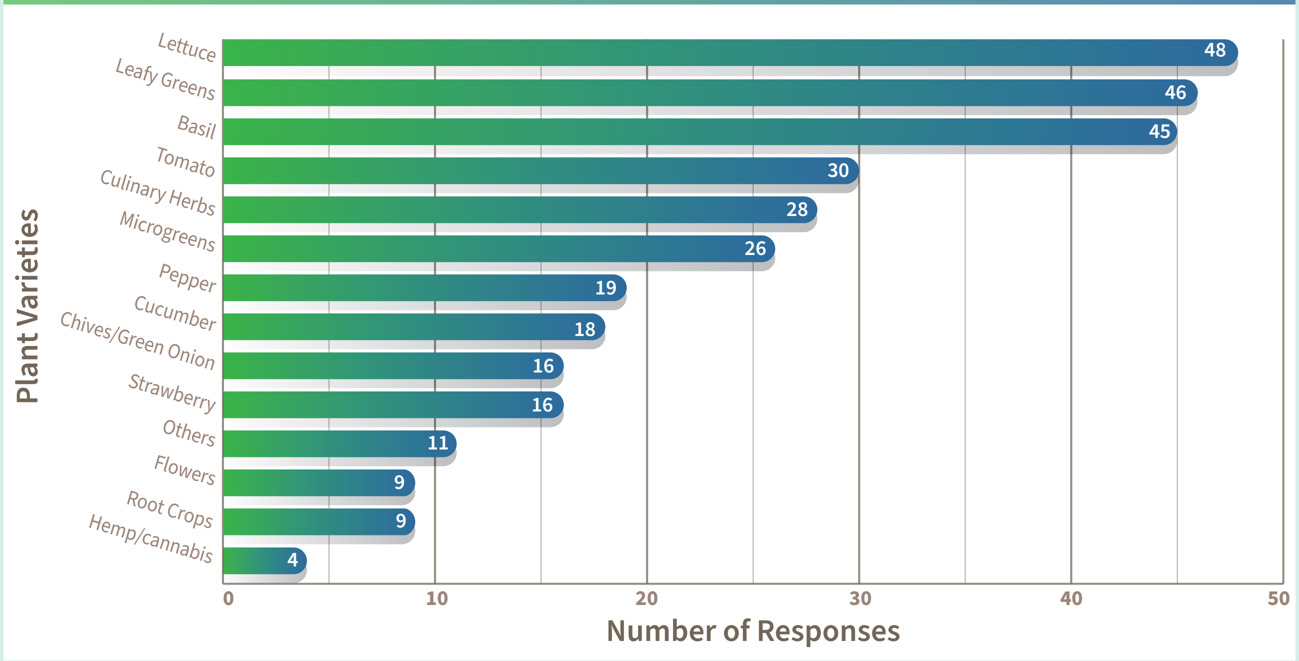
Figure 4 Overall Aquaponic Products and Services Sold (n=79)




## Figure 5. Plant Varieties Grown (n=56)

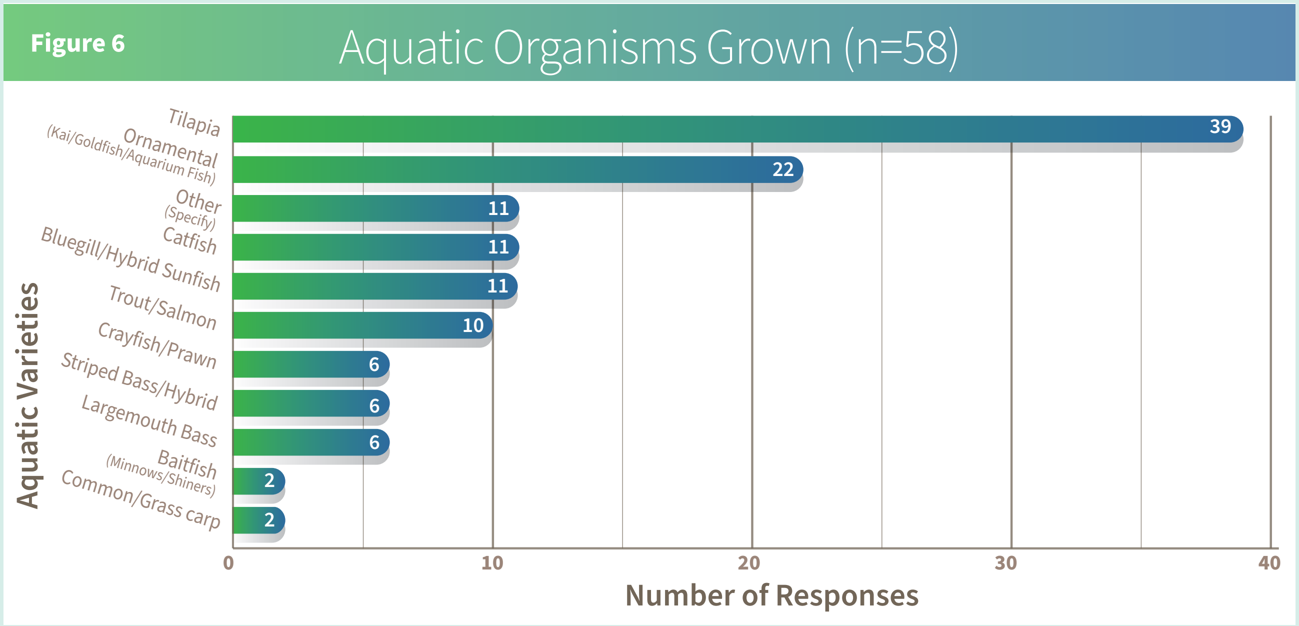
- Lettuce, leafy greens, and basil are the most common plants cultivated in aquaponics.
- Many respondents plant a diverse array of products, rather than monocultures.

Figure 5 Plant Varieties Grown (n=56)



## Figure 6. Aquatic Organisms Grown (n=58)

- Tilapia is the most utilized fish species for aquaponic production and is a source of protein for communities.
- Ornamental fish, such as koi, goldfish, and aquarium fish are the second highest.




## C. Economics & Markets

A key to building the industry is understanding the current economic situation to position the operations for long term financial viability. Many farms sell their products, yet only 14 claim to be profitable. Figures 7 & 8 focus on the 14 profitable farms, while Figure 9 provides a comparison to the non-profitable operations.

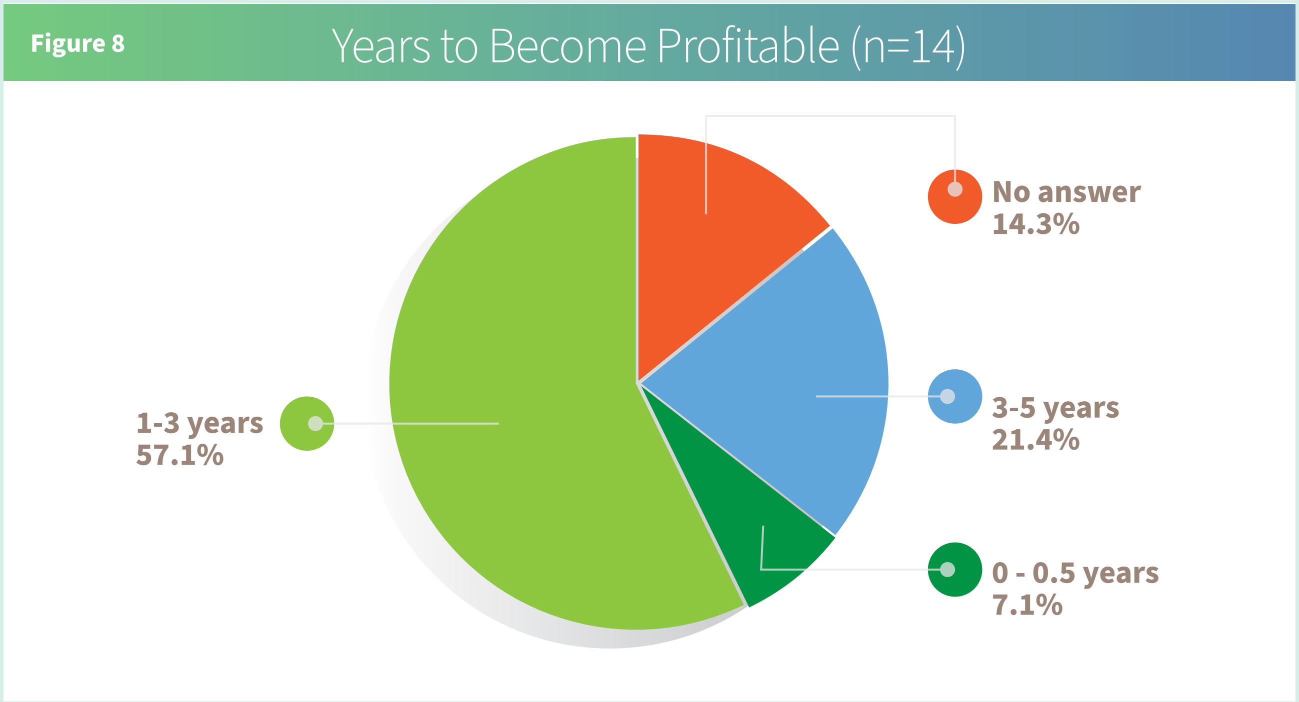
## Figure 7. Average Annual Revenue for Profitable Producers (n=7)

- Only seven respondents provided answers to this question, although there were a total of 14 who identified their farm as profitable.
- The average annual revenue from fish production is $77,000 USD.
- The average annual revenue from plant production is $483,585 USD.
- Revenue from equipment, supplies, and services averages $42,857 USD.
- There is a large variation in production values.

| Field | Minimum | Maximum | Median | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Fish Production | 0 | 500,000 | 5,000 | 77,000 | 186,725.28 |
| Plant Production | 95 | 3,000,000 | 50,000 | 483,585 | 1,111,166.34 |
| Agrotourism | 0 | 18,000 | 0 | 2,857.14 | 6,718.84 |
| Constructing Systems for Others | 0 | 0 | 0 | 0 | 0 |
| Consulting Services | 0 | 25,000 | 0 | 3,572.14 | 9,448.79 |
| Education/training | 0 | 0 | 0 | 0 | 0 |
| Equipment/supplies/services | 0 | 300,000 | 0 | 42,857.14 | 113,389.34 |

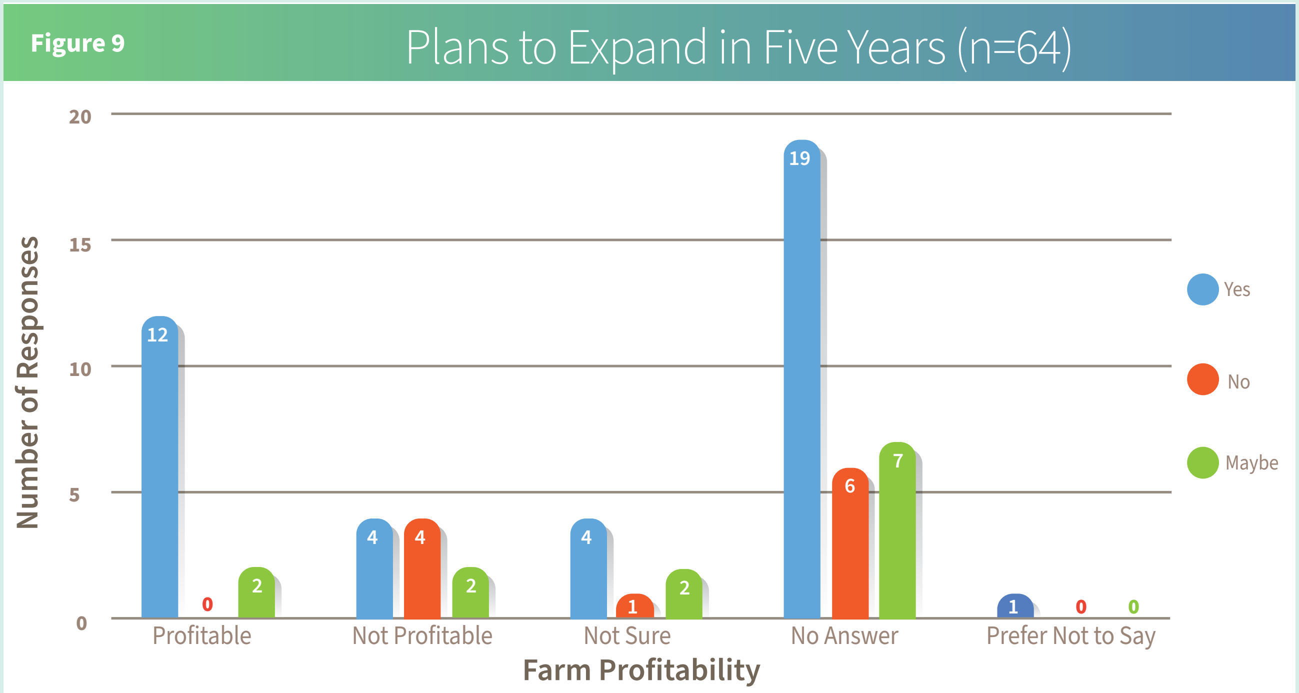
### Figure 8: Years to Become Profitable (n=14)

The most common amount of time before a farm turned a profit was 1-3 years.



## Figure 9: Plans to Expand in Five Years (n=64)

- Of the 14 profitable farms, 85% plan to expand in five years.
- Of the 10 farms that indicated they were not profitable, only 40% intend to upscale.




## Figure 10. Market Distribution of Fish (n=35)

- This table illustrates the percentage of fish marketed at specific venues.
- Although they are marketed, that does not indicate a profit was made.
- Most fish are sold directly to consumers, at restaurants, or not sold.

| Field | Minimum | Maximum | Median | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Farmers Market | 0 | 20.00 | 0 | 1.14 | 4.71 |
| Supermarket | 0 | 90.00 | 0 | 6.00 | 19.58 |
| Restaurant | 0 | 100.00 | 0 | 10.63 | 25.03 |
| Direct to consumer | 0 | 100.00 | 0 | 20.80 | 35.98 |
| Donations (Food banks, shelters, family and friends) | 0 | 100.00 | 0 | 7.43 | 24.66 |
| Not sold | 0 | 100.00 | 0 | 22.57 | 38.83 |

## Figure 11. Market Distribution of Plants (n=34)

- This table illustrates the percentage of plants marketed at specific venues.
- Plants have a wider spread of market distribution than aquatic organisms.

| Field | Minimum | Maximum | Median | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Farmers Market | 0 | 100.00 | 0 | 14.94 | 28.93 |
| Supermarket | 0 | 95.00 | 0 | 16.57 | 30.26 |
| Restaurant | 0 | 100.00 | 0 | 17.00 | 29.56 |
| Direct to consumer | 0 | 100.00 | 5 | 27.49 | 37.01 |
| Donations (Food banks, shelters, family and friends) | 0 | 100.00 | 0 | 6.57 | 18.70 |
| Not sold | 0 | 100.00 | 0 | 6.62 | 20.55 |

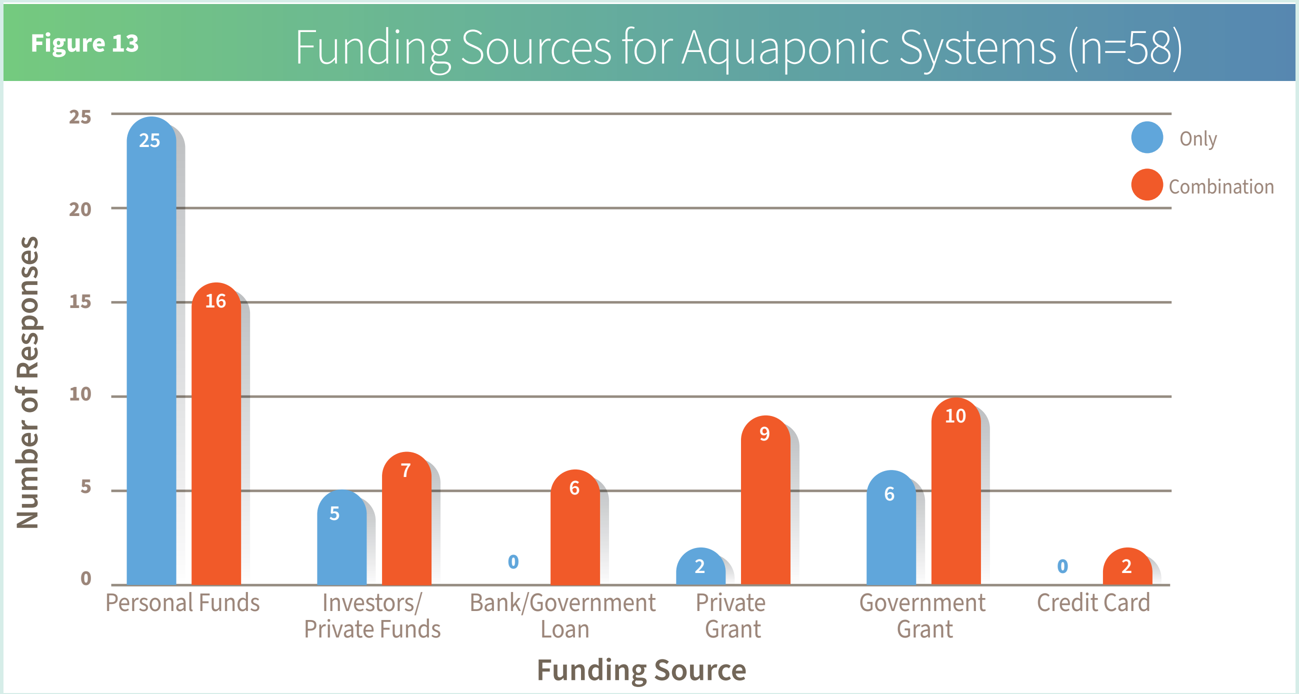
## Figure 12. Initial Investment Costs for Aquaponic Businesses (n=18)

- Aquaponic producers spend the most money on buildings, vehicles, greenhouses/high tunnels, construction labor, and "other," undefined expenses.

| Products | Minimum | Maximum | Median | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Buildings | 0.00 | 600,000 | 5,000 | 74,277.78 | 156,465.01 |
| Construction Labor | 0.00 | 150,000 | 3,500 | 26,277.78 | 40,674.90 |
| Fish System/ Equipment | 0.00 | 130,000 | 3,000 | 22,241.94 | 37,709.24 |
| Greenhouse/ High Tunnel | 0.00 | 165,000 | 0 | 23,000.00 | 45,533.44 |
| Land | 0.00 | 150,000 | 0 | 15,733.33 | 39,272.62 |
| Plant System/ Equipment | 0.00 | 60,000 | 3,000 | 10,722.22 | 17,536.70 |
| Tools | 0.00 | 50,000 | 0 | 4,527.78 | 12,059.26 |
| Vehicles | 0.00 | 800,000 | 0 | 45,444.44 | 188,334.88 |
| Other | 0.00 | 1,100,000 | 0 | 62,777.78 | 258,924.37 |

## Figure 13. Funding Sources for Aquaponic Systems (n=58)

- The majority of respondents use personal funds to support their business.
- Only 27% receive any government grant assistance.




## Figure 14. Operational Costs for Aquaponic Businesses (n=11)

- The most prevalent operational costs are labor, fish inputs, and plant inputs.

| Products | Minimum | Maximum | Median | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Electricity | 0.00 | 26,000 | 3,000 | 5,763.64 | 7,776.41 |
| Energy/Gas | 0.00 | 3,000 | 0 | 600.00 | 1,019.80 |
| Fish Inputs | 0.00 | 65,000 | 400 | 6,495.45 | 19,417.50 |
| Plant Inputs | 0.00 | 39,000 | 750 | 4,186.36 | 11,562.03 |
| Interest on Loans | 0.00 | 24,000 | 0 | 2,227.27 | 7,222.75 |
| Insurance | 0.00 | 8,500 | 500 | 1,331.82 | 2,462.34 |
| Labor | 0.00 | 185,000 | 0 | 25,954.55 | 57,978.64 |
| Management | 0.00 | 20,000 | 0 | 1,818.18 | 6,030.23 |

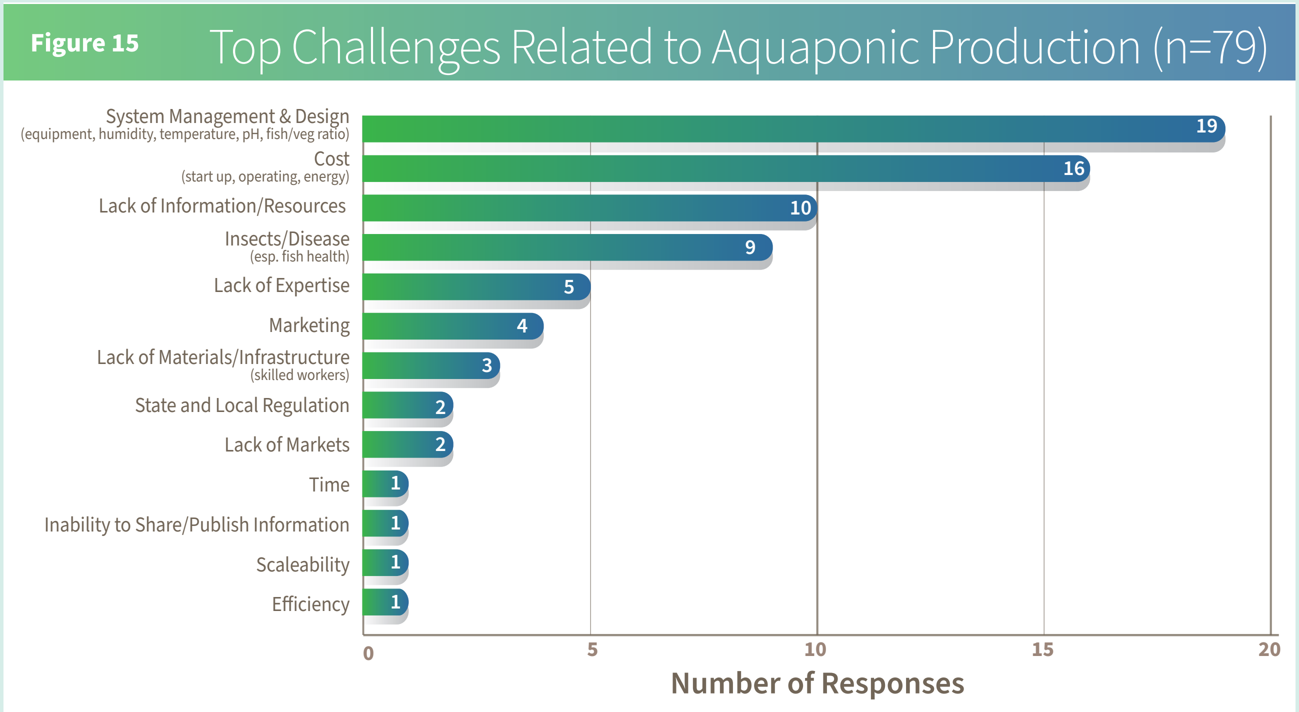
| Products | Minimum | Maximum | Median | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Repairs/ Maintenance | 0.00 | 10,000 | 4,000 | 3,268.18 | 3,166.41 |
| Water | 0.00 | 1,200 | 0 | 172.73 | 384.94 |

## D. Challenges

Challenges faced by aquaponics entrepreneurs include those related to the overall operation of the facilities. Additionally, many face regulatory roadblocks, as well as permit and licenser requirements.

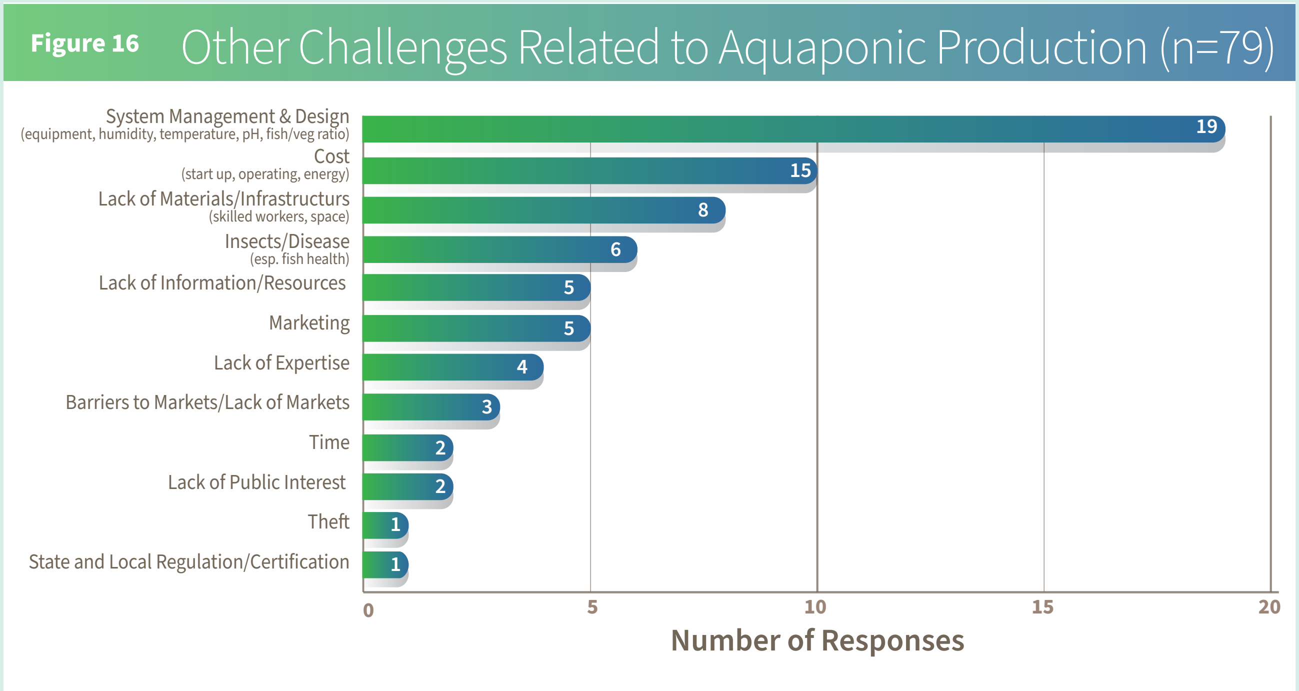
### Figure 15. Top Challenges Related to Aquaponic Production (n=79)

- According to 19 respondents, the biggest challenges are system management and design. This consists of maintaining environmental controls, such as the pH and temperature of water, level of humidity, ratio of fish to plants, and equipment maintenance.
- Costs for initial investment, operation, and energy are also primary obstacles.
- There is a general lack of information and resources, whether that be educational resources or materials for the system itself.



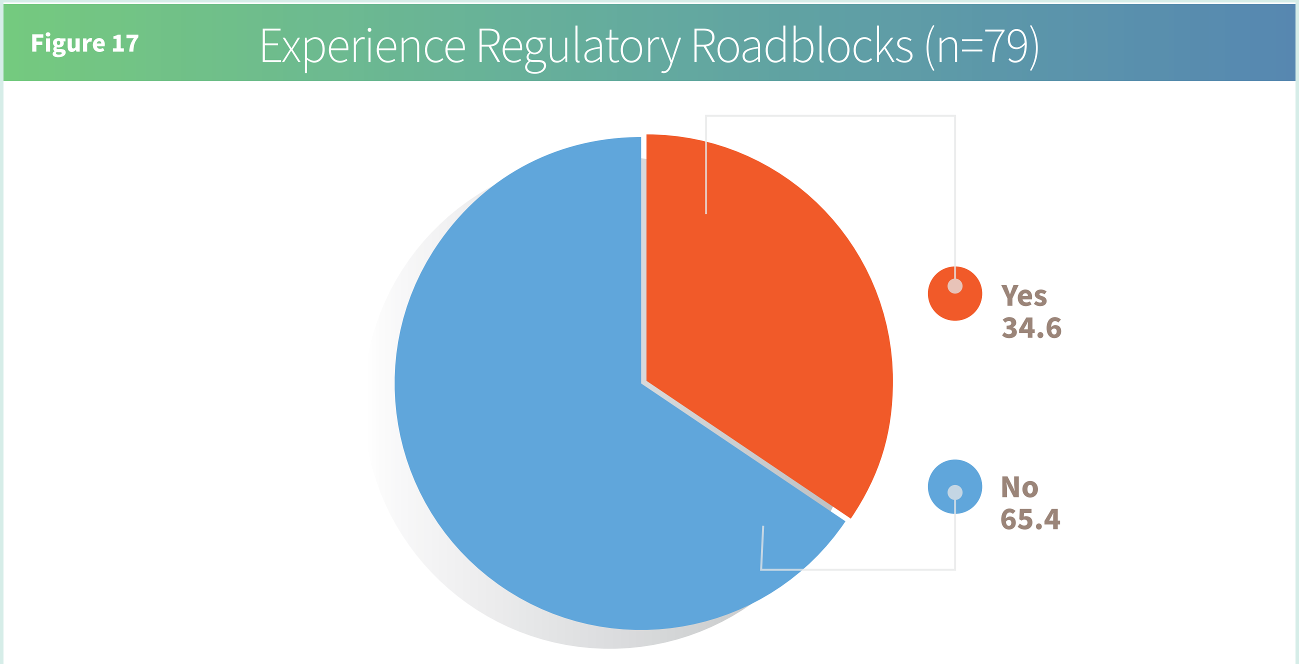
## Figure 16. Other Challenges Related to Aquaponic Production (n=79)

- According to 19 respondents, the basic system structure is one of the highest challenges.
- Costs factor in second highest, followed by other infrastructural components, such as skilled workers.



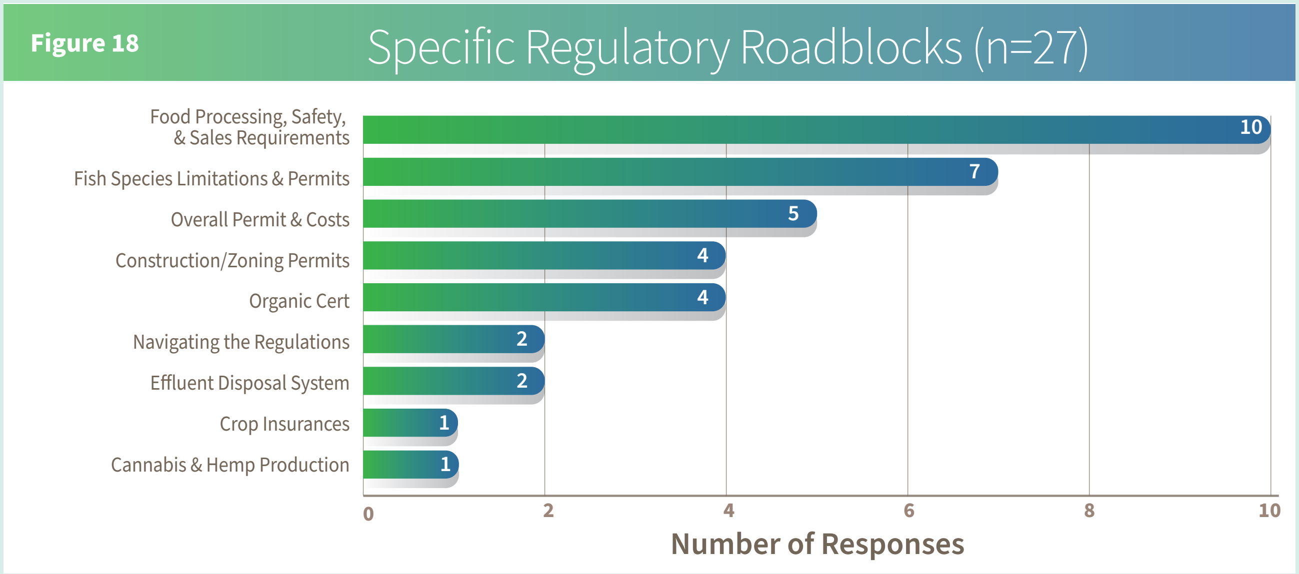

## Figure 17. Experience Regulatory Roadblocks (n=79)

- Over one-third indicate they have encountered regulatory roadblocks.
- Those who encounter regulatory roadblocks, often identify more than one.



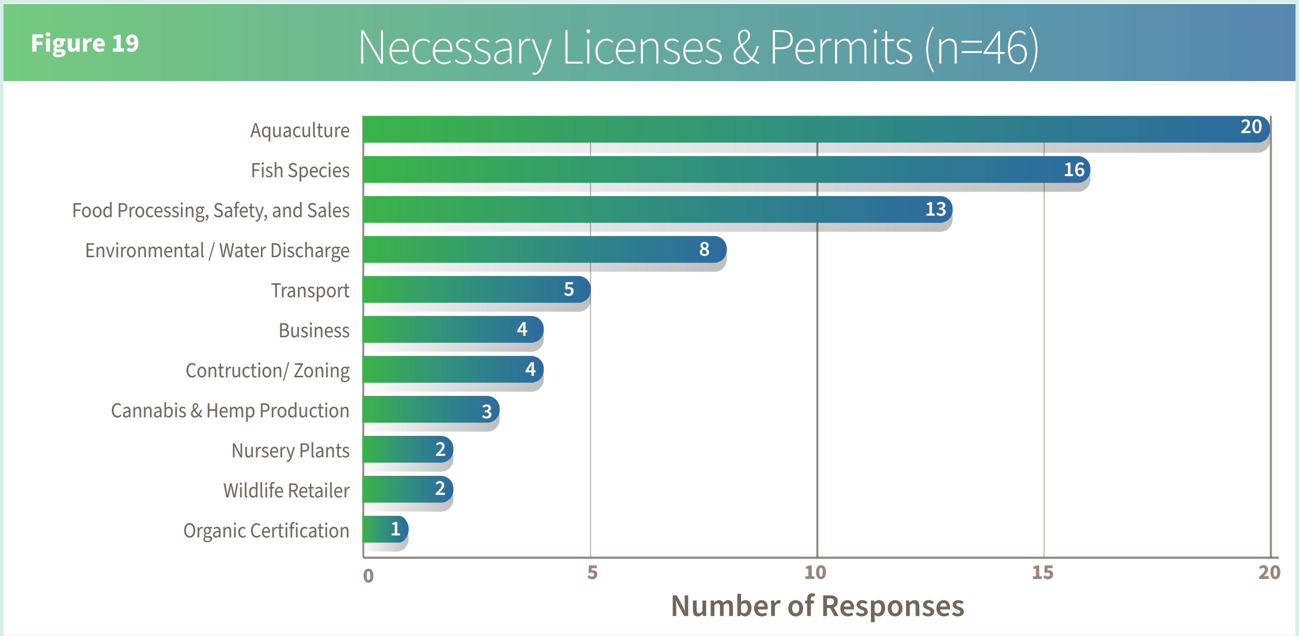
## Figure 18. Specific Regulatory Roadblocks (n=27)

- Issues related to selling produce and fish are the highest regulatory roadblock, both at the state and federal levels. This includes sales permits, food processing, and food safety.
- The second highest roadblock are permits and licenses associated with importation and use of fish species, especially non-native species.




## Figure 19. Necessary Licenses & Permits (n=46)

- The top licenses required are state aquaculture permits.
- The use and transportation of fish are the next most sought after licenses, again at the state level.



# V. RECOMMENDATIONS

The survey results indicate that current aquaponic growers have the ability to provide a variety of fresh fruits, vegetables, other plants, and fish, thus contributing to food security. Additionally, if they have the support to be profitable, they can be a source of employment and economic development.

Legislative action is required at the state and federal levels to support this growing industry. Key challenges for aquaponic operators are as follows:

- Systems management and design.
- Increase funding for initial investments.
- Access to information and education.
- Food safety, food processing, and sales permits and licenses.

The top challenge is systems management. Basic infrastructural support is one of the first roadblocks for entrepreneurs when building aquaponic farms. Systems design can be difficult, because there is no single correct way to develop an aquaponic system. Creativity and ability to manage whatever form is built lies with the operator. If a grower has little experience in system design and operation, there are many potential pitfalls in the build process that can later be problematic and even prohibitive for long term operations. Information is key for success.

In addition to personal experience, there is a lack of access to both formal and informal education about aquaponic systems. More expansive networks of certifications, academic courses, online videos and other educational materials are necessary to expand a professional and successful industry. Aquaponic producers are interested in establishing local and regional infrastructure for resource-sharing between producers. This will partially alleviate the steep startup costs for this type of system as fewer errors are made in design and building, and more information and training is available. Additionally, producers have stated that an increase in sources of funding is necessary.

Food safety, food processing, and sales permits are major hurdles for operations to be more profitable. One respondent has intentionally maintained a small operation to avoid the array of licenses and certifications necessary to market at a more profitable level. Another commented, "Well, as in any business there are dozens of licensing requirements simply to do business that restricts small businesses from competitive practices with big business." If the process was more accessible, more aquaponic operations could thrive and prosper with the appropriate state and federal permits, licenses, and certifications.

Specifically, we recommend the following:

1. States and local governments should collaborate with experienced operators to develop specific permitting standards and checklists, readily accessible for aquaponic entrepreneurs to better understand permitting requirements and processes, and reduce barriers to entry;
2. Aquaponic farmers and aquaponic organizations should collectively create regional practice guides to support ongoing industry development;
3. Government entities should recognize and support aquaponics as an expanding and sustainable form of agriculture, and assist in promoting aquaponic farms, farmers, and products in the market;

4. Government entities should highlight sustainable and innovative agriculture, by including aquaponics on websites and in other media; and,

5. Government entities should offer aquaponic growers the same access to support and tools provided to other farmers, including government grants, equipment, insurance and other assistance.

## VI. CONCLUSIONS

Aquaponics is expanding nationwide and many operations are producing sufficient products and offering other services to be economically viable. However, there are a number of challenges hindering widespread development. Based on a recent national survey of aquaponic farms, the primary barriers include funding, clear permitting standards, training, and best practices information, access to other support resources, and policies that promote industry growth.

Additionally, aquaponics offers solutions for minimizing the use of fossil fuels and maximizing food production to address challenges of a changing climate. By incorporating clean energy sources, aquaponic systems can be self-sustaining and sustainable. Based on this information, there are a number of strategies that state and local governments can employ to support and uplift this smart and sustainable approach to growing food in a changing climate.


**Growing Local NOLA in New Orleans, LA**

# APPENDICES

### Appendix 1: Aquaponics Survey - Producers

https://drive.google.com/file/d/11tD2ay6P00A2ADZU8wCUzkA_JM7mCnEx/view?usp=sharing

### Appendix 2: Map of Aquaponic Producers

Map illustrates phase of operation: research, design, facility constructed, operating.


### National Recirculating Farms Map

https://www.recirculatingfarms.org/resources/#rfmap

- Hydroponic Farm
- Recirculating Aquaculture Farm
- Aquaponic Farm
- Mixed-Method Farm

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RECIRCULATING FARMS