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Overview and Cost of a Small-scale Aquaponic Build at The Ohio State University

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In the summer of 2019, The Ohio State University created and published the YouTube video *The Ohio State University Small-Scale Aquaponic Build*. This 16-minute video captured the build process of three replicated aquaponic systems at The Ohio State University South Centers in Piketon, Ohio (Figures 1 and 2). The replicates compared aquaponics to hydroponics as well as various plant and fish species. Three replicates were also built at Central State University in Wilberforce, Ohio. Since publishing, the aquaponic video has over 17,000 views, and the Ohio State Aquaculture Extension program receives periodic requests for the breakdown of costs for a single aquaponic system (i.e., fish tank, filters, hydroponic grow bed, sump, and all accompanying supplies and parts). This fact sheet supplements the video and addresses these questions.

The major aquaponic system components (i.e., tanks and stands) are from PolyTank Co. in Litchfield, Minnesota. Individual tanks, filters, hydroponic tanks, and sumps were purchased as this was not a standard “complete package” system. You may find it more advantageous to purchase a complete system, build the system or some components, expand the system, or upgrade certain components. For example, a mineralization tank may be added, brass connectors may be used instead of polyethylene, or grow beds may be constructed using wood and liners.

The three replicated aquaponic systems at South Centers include several components (Figure 1):

1. **Fish tank:** center standpipe; system is gravity fed until water reaches sump and lifts water back into fish tank; fish tank is aerated
2. **Primary filter:** conical bottom with single baffle to slow water down and allow solids to settle to bottom of filter to allow purging of solids via ball valve
3. **Secondary filter:** conical bottom with bird netting to promote nitrifying bacteria; conical bottom to allow purging of solids via ball valve; tank is aerated
4. **Deep-water culture bed:** location of the plants prior to adding floating plant rafts; arrow indicates water flow direction; bed is aerated
5. **Polyvinyl chloride (PVC) return pipe:** gravity moves water that overflows from the deep-water culture bed to the sump
6. **Sump:** where water returns from the deep-water culture bed; includes a submersible pump
7. **Return water line:** sump pump lifts water back into the fish tank to complete the cycle
8. **Air blower and manifold:** provides oxygen to the fish tank, secondary filtration, plant grow bed, and all areas where beneficial bacteria substantially colonize

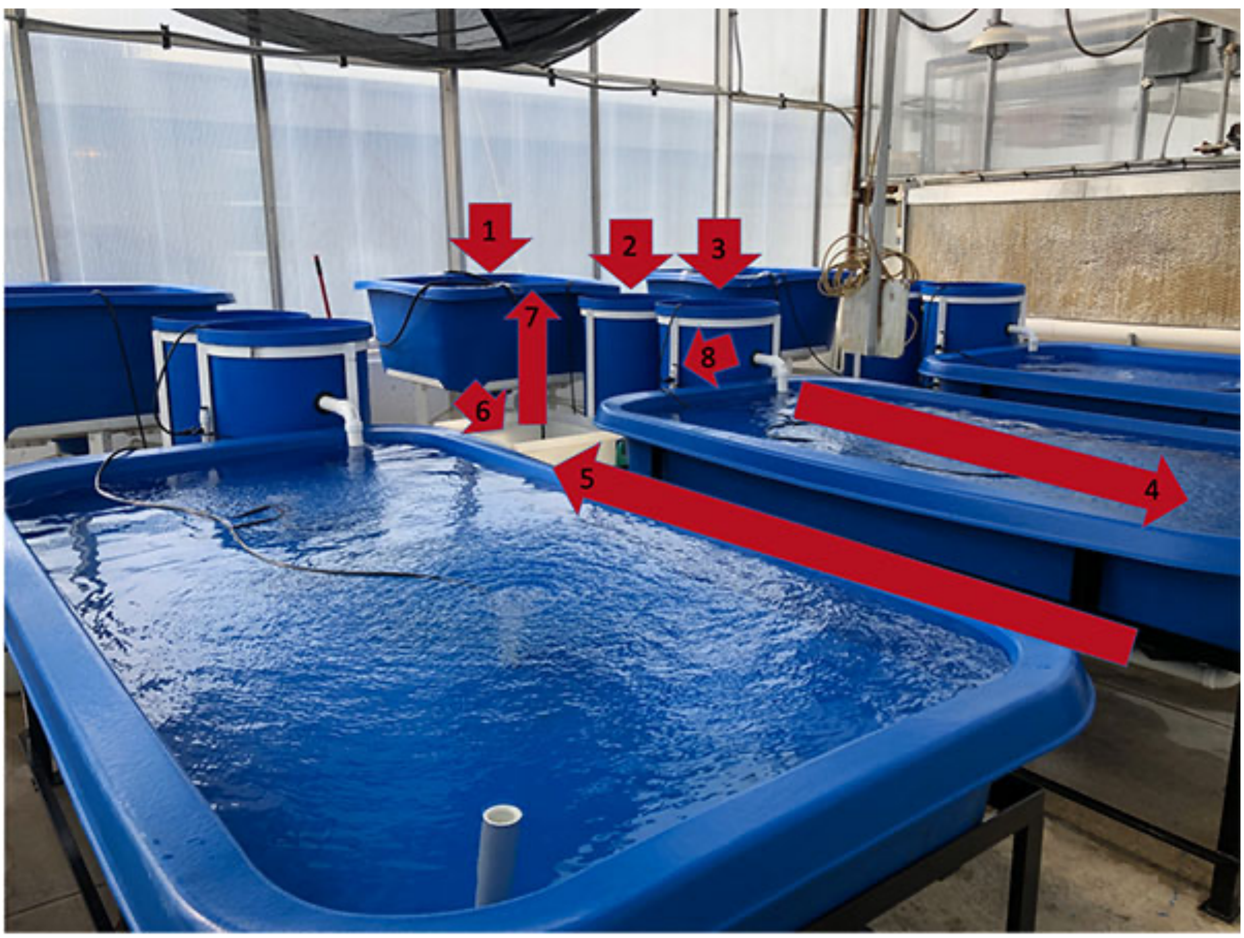

Figure 1. Three replicated systems of the small-scale aquaponic systems at South Centers. Photo by Matthew A. Smith, Ohio State University Extension.

Figure 2. Alternate angle of the small-scale aquaponic systems at South Centers. Photo by Matthew A. Smith, Ohio State University Extension.

The aquaponic system build was influenced by University of the Virgin Islands and Kentucky State University aquaponic systems. Mineralization tanks and other small modifications have been added to the Ohio State Extension system since the creation of the video. The total cost to build each aquaponic system in 2018 was approximately USD $3,000 (Table 1). The total cost to build the same aquaponic system in 2022 was approximately $4,800 (Table 2). Please note that current prices may be different. Lastly, it is important to budget additional funds for freight of large items as shipping may cost more than the purchased items.

Table 1. Description and costs of a single South Centers small-scale aquaponic system in 2018.

Table 2. Description and costs of a single South Centers small-scale aquaponic system in 2022.

Discussion

Tables 1 and 2 includes the cost and most of the materials used for constructing a single Ohio State Extension small-scale aquaponic system. Some companies can, at their discretion, provide discounts to universities. Discounts are usually offered because the items are for research studies. Our 2018 records do not indicate a discount was received, but according to PolyTank Co., it is likely there was a discount applied (Table 1). However, 2022 line items are marked entirely at retail (Table 2).

Not all items used by Ohio State Extension were included in Table 1 and Table 2 as they were already on hand or not needed (Table 3). A scale to weigh the fish and plants, along with miscellaneous building tools and water quality supplies, were not included. Additional tools or supplies that may also need to be purchased include PVC cleaner, PVC primer, PVC glue, PVC cutters, hole saws, drill, zip ties, plumber's tape, and other items. The fish, fish food, and plants or seeds also need to be purchased. Consider integrated pest management strategies and costs when developing a budget. The cost for the system may increase upwards of $500 or more depending on what you do not have on hand.

Table 3. Examples of items that may need to be purchased if not already owned.

Materials and Supplies	Biological Items
PVC cleaner, primer, and glue	Plants or seeds
PVC cutters	Fish
Hole saw	Beneficial bacteria
Electric drill	Beneficial insects
Zip ties	

Plumber's tape	
Fish food	
Concrete blocks	
Artificial lighting and heat	
Weight scale	
Water quality supplies	
Insect sticky traps	
Extension cord	
Shade cloth	
Dehumidifier	
Plant nutrients	
Back up items, such as additional air pumps	

The fish tank is approximately 165 gallons. We maintain approximately 2" of freeboard on the 180-gallon fish tank. Similar systems have produced 1 lb. of tilapia (sometimes much greater) per 5 gallons of water. Therefore, it is feasible that a single 165-gallon fish tank can produce a minimum of 33 lb. of tilapia (1 lb. of tilapia per 5 gal. of water) and upwards of approximately 82.5 lb. of fish in less than one year (1 lb. of fish per 2 gal. of water).

A hobbyist or small-scale producer must set goals before designing and system and spending money. Some line items, such as labor, were not considered for this system, but are an economic cost to consider if the intent is to develop a business. Growing and maintaining fish and plants takes dedication, time, effort, and money. As the system limits are pushed (e.g., increasing the stocking density of fish), the chances of something going wrong increases. Fish, bacteria, and plants require high-quality water which is a product of adequate aeration and circulation. Loss of power for any significant time in a higher density system will likely lead to the loss of fish. The small-scale Ohio State Extension aquaponic systems do not have artificial lighting. Artificial lighting is needed if the system will be housed indoors or in a greenhouse/hoop house during winter months. A heat and electrical source will also be needed if the intent is to run the system year-round.

Additionally, some percentage of water will need to be replaced every day. Recirculating aquaculture systems and aquaponic systems usually retain >90% of their water per day. The greatest water loss occurs when backwashing or flushing/cleaning filters. Water loss also occurs through evaporation, transpiration, spillage, and leakage. Mineralization tanks have been added to many aquaponic systems to capture nutrient-rich water that would otherwise be lost when flushing (i.e., cleaning) filters. Mineralization-tank water is heavily aerated to liberate nutrients and, after a period, most of the water is often added back to the coupled aquaponic system. This can decrease water use, improve production of plants, and increase overall efficiency of the system.

Conclusion

In 2022, the cost to replicate an Ohio State Extension small-scale aquaponic system would be approximately $4,800, not including taxes and freight cost (Table 2). Freight cost, especially for the larger components of the system, may substantially increase the cost of the system. The deep-water culture bed has holes for 112 plants (Figures 3 and 4), but you may decide to add or remove holes depending on the plants, lighting, and nutrient load in their system. The fish tank is stocked at research densities, not commercial

Figure 3. Three replicated small-scale aquaponic systems at South Centers with rafts, Rockwool cubes, and new plants added. Photo by Matthew A. Smith, Ohio State University Extension.

densities—commercial systems are more heavily stocked for economic sustainability. Pounds of fish harvested annually depend on your goals and tolerance for risk, species, size of species upon stocking, desired harvest weight, maintenance of the system, and other factors. You may also choose to produce a non-food fish species, such as koi or goldfish.

Aquaponic interest in Ohio and the Midwest continues to be strong, although turnover rates for those in production 10+ years is likely high. Reasons for turnover may be that operating and maintaining an aquaponic system requires more dedication, time, effort, and money than many realize. Ohio aquaponics and small-scale aquaculture also continues to be popular with secondary school teachers, including career technical center teachers. Proper planning, understanding your goals, and dedication can lead to a bountiful controlled environmental agricultural system— even at a hobby scale. You may find it more advantageous to purchase a complete system, engineer and fabricate the system or some components, expand the system, or upgrade certain components. Aquaponic systems involve electricity and water. Use caution and follow any instructions to prevent drowning, electrocution, or other injuries.

Ohio State University Extension is here to support your farm, educational programming, and hobby aquaponic system. The suggested readings below provide additional aquaponic system information and resources. Trade names in this fact sheet are for descriptive purposes only and do not imply endorsement or approval by Ohio State to the exclusion of other suitable products.

Thanks to Paul O'Bryant and Dean Rapp at South Centers for leading construction of the small-scale aquaponic systems, and Sarah Swanson for recording and assisting in publishing the YouTube instructional build video. Funding for the South Centers' aquaponic systems was provided by United States Department of Agriculture National Institute of Food and Agriculture (Grant no. 2017-38821-26411) awarded to Principal Investigator Krishnakumar Nedunuri of Central State University.

Suggested Readings

Hager, Janelle, Leigh Ann Bright, Josh Dusci, and James Tidwell. 2021. *Aquaponics Production*

Manual: A Practical Handbook for Growers. Kentucky State University. k

Figure 4. Three replicated small-scale aquaponic systems at South Centers with plants growing in them show the benefits of aquaponics to visitors during a facility tour. Photo by Matthew A. Smith, Ohio State University Extension.

suaquaculture.org/PDFs/Aquaponics%20Handbook%202021%20Updated%20.pdf.

Pattillo, Allen. 2017. “An Overview of Aquaponics Systems: Aquaculture Components” Technical Bulletin #124, North Central Regional Aquaculture Center, Iowa State University. store.extension.iastate.edu/product/15307.

Pattillo, Allen. 2017. “An Overview of Aquaponics Systems: Hydroponic Components” Technical Bulletin #123, North Central Regional Aquaculture Center, Iowa State University. store.extension.iastate.edu/product/15111.

Thompson, Kenneth, Tanya Mullen, Karin Ceralde, Cara Perry, and Rebecca Krall. 2022. *Aquaculture Teacher Manual*. Kentucky State University.

Instructional Video

Smith, Matthew A., and Sarah Swanson. 2019. The Ohio State University Small-Scale Aquaponic Build. South Centers. youtu.be/yk0rNzUBmT0.

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