



BUST LL MVPs

**Chop & Flip aquaponic system with
multiple grow beds**



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1. Overview

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Innovation Actor: BUST LL

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1.1. Abstract

Chop & Flip aquaponic system with multiple grow beds

The Chop-and-Flip aquaponic MVP is an innovative, sustainable-agriculture system that integrates aquaculture and hydroponics by repurposing a food-grade Intermediate Bulk Container (IBC) tote: the tote is cut and the upper portion is flipped open to serve as a shallow grow bed while the remaining lower section functions as the fish tank; additional modular grow beds are fabricated from cut barrels and filled with treated, washed gravel that provides mechanical and biological filtration as well as an anchor for plant roots. Seedlings are started in disposable plastic cups filled with sterilized, treated sawdust that supplies essential micronutrients and can be transplanted into the gravel media once roots are established. Water is circulated from the fish tank to the elevated beds, fish produce waste that is converted by bacteria into plant-available nutrients while the gravel media traps solids and supports biofiltration, then drains back to the tank, creating a nutrient-recycling, water-efficient loop that uses less water than traditional soil agriculture.

One drawback of a conventional Chop & Flip design with one single grow bed is the limited nutrient uptake capacity of the plants. This MVP addresses this issue by introducing multiple grow beds to increase the plant growing capacity and to balance nutrient production and consumption.

1.2. Photo



Figure 1: BUST outdoor aquaponic system with multiple grow beds

Value proposition of the Chop-and-Flip aquaponic system with multiple grow beds

The system promotes sustainable agriculture by integrating aquaculture and hydroponics, reducing reliance on soil and chemical fertilizer. By utilizing recycled materials such as IBC totes and waste cups, the system minimizes environmental impact and fosters a culture of sustainability. The ability to add multiple grow beds allows for larger-scale cultivation, providing flexibility for various crops and maximizing aquaculture yield. Using multiple grow beds mitigates a major drawback of the original Chop & Flip design, improving nutrient production and consumption balance.

1.3. Motivation and challenges addressed

In urban environments, land is often limited. This system maximizes both vertical and horizontal space, allowing for effective food production in small areas. In areas facing water shortages, the system's ability to recycle water minimizes consumption, making it a viable option for water-scarce regions. Traditional farming often results in nutrient runoff and wastage. The closed-loop system efficiently recycles nutrients from fish waste, ensuring that both plants and fish benefit from the nutrient cycle. The system addresses the issue of waste by using recycled materials, such as IBC totes and waste cups. This not only reduces waste but also demonstrates a model for recycling in agricultural practices.

The basis for this MVP is the Chop and Flip aquaponic system that is a popular implementation of the aquaponic principle. The original design where the top of one IBC is cut off and placed on top of the remaining tank has a couple of major drawbacks, one of which is the limited plant growing area. The small number of plants are not suitable to absorb and process all the nutrients that can be produced in the fish tank when it is stocked to capacity. This leads to either low water quality or suboptimal performance on the aquaculture part.

Adding more grow beds eliminates this major drawback of the original C&F design. More growing space allows for more plants and thus improves nutrient uptake, allowing for higher stocking density and higher feeding rates than the original C&F design. Consequently, adding more grow beds improves productivity not only on the plant side, but also improves aquaculture productivity.

1.4. Feedback process

The LL staff provides training sessions for students and community members, sharing knowledge about aquaponics, hydroponics and sustainable practices. This fosters a culture of learning and innovation. Students and researchers are also involved in hands-on experience by actively participating in the daily operations of the LL, gaining practical experience in managing the systems, understanding plant and fish care and troubleshooting common challenges. Innovative development (feedback loops): Continuous interaction between farmers, students and researchers allows for real-time feedback on system design and functionality. Innovations can be developed and tested based on this collaborative input. New techniques or technologies can be piloted in the LL, allowing for experimentation and validation before wider implementation in the community or commercial settings.

2. Implementation

2.1. MVP Design

Key components of the chopped and flipped aquaponic system with multiple grow beds include: IBC tote, grow beds, gravel filtration, plant containers, fish tank, barrels, PVC pipes.

The decision to use an IBC tote for both the fish tank and grow bed optimizes space and resource use, making it ideal for urban environments with limited space. Incorporating recycled materials such as grow cups and IBC totes reflects a commitment to sustainability and waste reduction, aligning with modern agricultural practices. The filtration systems were adapted after it was observed that the plant roots in the PVC pipe grow beds were encountering significant clogging due to unfiltered wastes from the fish tank. This clogging deprived the plants of oxygen, leading to poor growth. The filter systems now effectively remove these wastes, preventing clogging and ensuring adequate oxygen supply to the roots. Additional grow beds: The barrels also function as additional growing areas, allowing for more plants to be cultivated while providing an environment for beneficial bacterial to thrive. These additional grow beds increase nutrient uptake from the system, which in turn allows for higher stocking densities or prevents nutrient accumulation on the aquaculture side, improving overall water quality and ultimately supporting better fish yield.

2.2. Operations

Setup by cutting the IBC tote, filling the grow beds and preparing plant containers, planting, fish stocking, water circulation, nutrient cycling, monitoring, Training and community engagement.

The outdoor aquaponic system with multiple grow beds contains nutrient-rich water which flows from the fish tank through the filtration systems before reaching the grow beds. After nourishing the plants, the water is returned to the fish, completing the cycle. This closed-loop system ensures efficient water use and nutrient recycling.

2.3. Bill of materials & required tools

Table 1. A table of materials required to build one unit of the MVP, including costs.

Item	Quantity*	Unit cost (FCFA)	Total cost (FCFA)
IBC tote	1	85000	85000
Aquarium pump	1	50000	50000
Barrels	3 halves	8500	25500
Gravel	11 wheelbarrows	3500	38500
Sawdust	10 kg	200	2000
Disposable gloves	5 pairs	150	750
Grow cups	50	25	1250
Tank adapters	6	1500	9000
Adaptors 32mm	8	300	2400
Valve 32mm	4	2000	8000
Elbow 32mm	2	300	600
Tee 32mm	3	400	1200
Plug 63mm	8	800	6400
Pressure pipe 32	1	2200	2200
Pressure elbow ¾	8	200	1600

Pressure pipe ¾	1	1200	1200
Valve ¾	4	500	2000
Pipe 63 normalizer	1	3500	3500
Wood 2x6	4	3300	13200
Nail	2 kg	2400	4800
APPF pipe	5	500	2500
		Total	261,600

Table 2. Tools required

Item	Quantity	Unit cost (FCFA)	Total cost (FCFA)
Carpenter hammer	1	2500	2500
Carpenter saw	1	3500	3500
		Total	6,000

3. Economics

3.1. Business model

This small scale aquaponic system lends itself well for family subsistence farming or for marketing the produce and fish on local markets.

The Living Lab has the idea of partnering with urban developers to directly integrate aquaponics systems into new residential or commercial projects, enhancing urban sustainability by providing fresh food in city environments in the process. Additional business opportunities lie in offering workshops and training sessions on aquaponics for schools, community groups and agricultural enthusiasts, additionally empowering individuals and communities with sustainable farming knowledge and skills.

4. Future Improvements

4.1. SWOT analysis of the MVP

Strengths

- The MVP promotes resource efficiency by recycling water and nutrients, reducing waste.
- The MVP can be implemented in urban areas or limited spaces, making it versatile for various locations.
- The system also provides fresh, organic vegetables and fish, appealing to health-conscious consumers.

Weaknesses

- While materials are relatively low-cost, initial setup and training can require significant investment.
- Furthermore, successful operation requires knowledge of aquaponics, which may limit participation without proper training.

Opportunities

- Increasing consumer interest in locally sourced and organic foods provides a market opportunity.

- Collaborating with schools and universities can enhance community involvement and generate additional revenue.

Threats

- Other local farms and aquaponic systems may compete for same customer base.
- Risks of pests and diseases can threaten both fish and plant health, requiring effective management strategies.
- Also changes in climate or water availability can impact fish and plant health

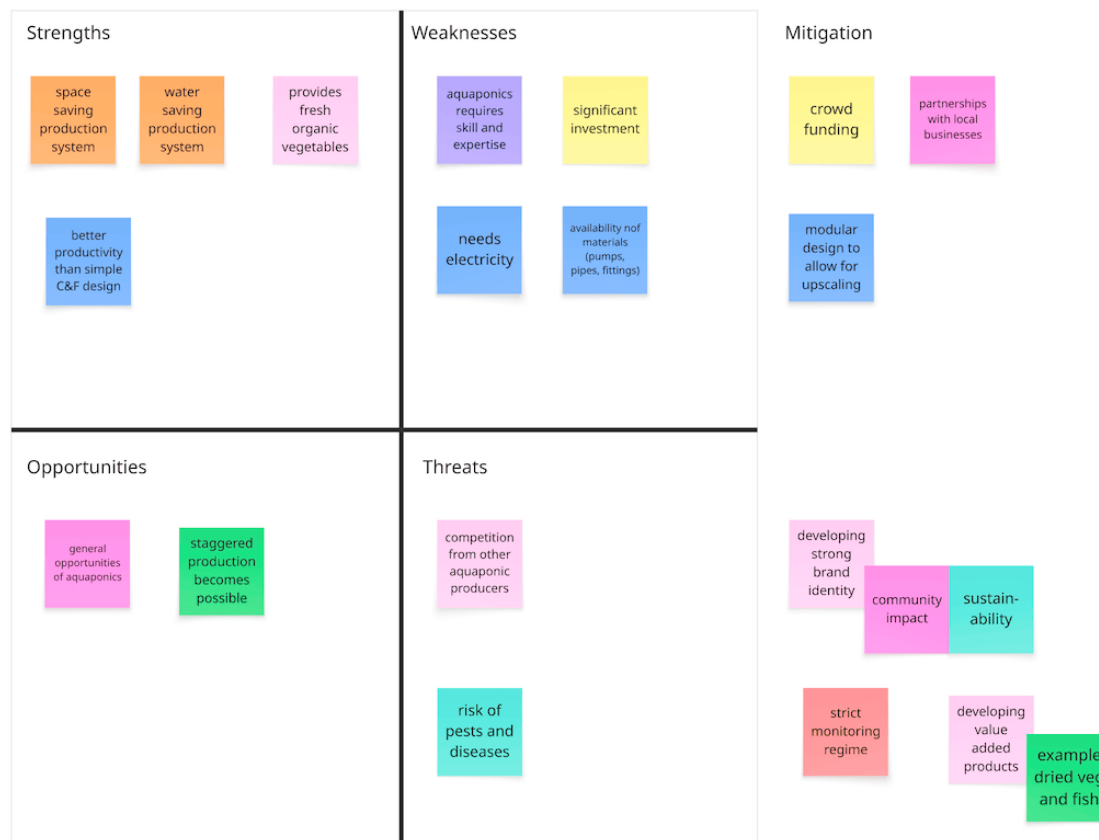


Figure 2: SWOT – BUST LL – Chopped & Flipped with multiple grow beds

4.2. Optimization

- Utilize crowd funding platforms to raise funds for initial setup costs.
- Seeking partnerships with local businesses or NGOs that may provide financial assistance or materials.
- Design the system to be expandable, allowing for incremental growth as demand increases.

4.3. Threat mitigation

- Develop a strong brand identity focused on sustainability and community impact to differentiate from competitors.
- Implement risk management strategies, such as backup systems for water supply and climate control.
- Expand product offerings to include value-added products (dried vegetables and fish) to attract a broader customer base.
- Conduct routine checks for fish and plants to identify issues early and take corrective action.

5. Appendices

5.1. Photographs



Figure 3: Original chopped and flipped aquaponic system with one grow bed (June 2023)



Figure 4: First iteration of chopped and flipped aquaponic system with two grow beds (February 2025)



Figure 5: Second iteration of chopped and flipped with multiple grow beds for medium sized farms (June 2025)