



Minimum Viable Product Documentation
MVP-Manual chop-and-flip aquaponics system
UDS Living Lab



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1 Overview

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1.1 Abstract

The manually operated Chop and Flip aquaponics system, developed under the Living Lab initiative at UDS in Tamale, Ghana, presents a low-tech, sustainable solution for small-scale urban agriculture. Designed using a halved Intermediate Bulk Container (IBC), the system integrates fish farming and vegetable cultivation within a compact, electricity-free setup. One section of the IBC serves as a fish tank, while the other functions as a grow bed filled with soilless media. Nutrient-rich water from the fish tank is manually transferred to irrigate the plants, which in turn purify the water before it drains back into the tank creating a closed-loop system that conserves water and eliminates the need for mechanical filtration. The system is tailored for urban backyards and low-resource environments, promoting food security, physical activity, and community engagement. Its affordability and simplicity make it accessible to individuals, households, schools, and community groups, while its dual production of fish and vegetables offers nutritional and economic benefits. Despite its strengths, the system faces challenges such as labor intensity, limited scalability, and the need for consistent monitoring. Optimization strategies include modular expansion, basic water testing tools, and climate-resilient crop selection. As a Minimum Viable Product (MVP), the system serves as a foundation for future enhancements, including solar-powered components and smart monitoring. It also fits into a lean business model through direct sales, training workshops, and franchising opportunities. Overall, the Chop and Flip aquaponics system exemplifies grassroots innovation in sustainable agriculture, with strong potential for replication and impact across urban communities.

1.2 Photos



Figure 1: Two manual aquaponic systems side by side



Figure 2: Photos of the manual Chop & Flip aquaponic system in UDS LL

1.3 Motivation and challenges addressed

In the face of rising urbanization, food insecurity, and environmental degradation, innovative solutions that promote sustainable agriculture are more critical than ever. One such solution is the manually operated aquaponics system using an Intermediate Bulk Container (IBC), which integrates fish farming and vegetable cultivation in a compact, electricity-free setup. This system is not only a testament to resourcefulness but also a practical model for urban households seeking self-sufficiency and ecological balance.

The primary motivation behind this setup is **accessibility**. By eliminating the need for electricity and complex machinery, the system becomes viable for low-income communities and individuals living in areas with unreliable power supply. Its simplicity encourages widespread adoption, especially in urban backyards where space is limited. The use of a single IBC tank, split into a fish tank and a grow bed filled with soilless media, allows for efficient use of vertical and horizontal space, making it ideal for densely populated neighborhoods. Another compelling driver is sustainability. The system operates on a closed-loop principle: nutrient-rich water from the fish tank is manually fetched to irrigate the vegetables, which in turn purify the water before it drains back into the fish tank. This natural filtration process reduces water waste and minimizes the need for chemical fertilizers, aligning with eco-friendly farming practices. Moreover, the manual operation promotes physical activity, turning daily tasks like watering and feeding into opportunities for exercise and engagement with nature. Cost-effectiveness is also a key motivator. The system requires minimal financial investment, making it accessible to individuals and families who may not have the capital for high-tech agricultural solutions. It uses very little water compared to traditional farming, which is especially beneficial in regions facing water scarcity. The dual production of fish and vegetables offers nutritional diversity and the potential for income generation through local sales.

However, despite its many advantages, the system is not without challenges. Manual operation, while empowering, can be labor-intensive and time-consuming, especially for individuals with limited mobility or busy schedules. The absence of automated controls means that water quality must be

monitored closely to prevent harm to the fish, and consistent attention is required to maintain balance between the aquatic and plant components. Another challenge lies in scalability. While the system works well for small households, expanding it to serve larger communities or commercial purposes would require additional infrastructure, labor, and possibly the integration of low-energy technologies. Pest control and disease management also pose risks, particularly in urban environments where contamination can spread quickly. Lastly, knowledge gaps can hinder adoption. Without proper training or guidance, users may struggle to maintain the delicate ecosystem, leading to poor yields or system failure. Addressing this requires community education, demonstration projects, and support networks to ensure long-term success.

1.4 Feedback process

Since the establishment of the manually operated Chop and Flip aquaponics system, the response from visitors and potential adopters has been overwhelmingly positive. Many have expressed strong interest in the simplicity, affordability, and practicality of the design, particularly its suitability for small urban spaces and its independence from electricity. Encouraged by what they saw, several visitors have gone on to construct their own systems, which are now fully operational. This early adoption not only validates the system's viability as a MVP but also demonstrates its potential for scalability and community-level impact. The feedback affirms that the system meets a real need for sustainable, low-tech food production and has sparked enthusiasm for further replication and improvement.



Figure 3: Photos of Manual Chop & Flip aquaponic systems from adopters

2 Implementation

2.1 MVP Design

This aquaponics system is built using a single IBC tank that has been divided (3/4 to house fish and 1/4 to grow vegetable) to create two functional compartments. Three-quarter section serves as a **fish tank**, housing species such as tilapia or catfish, while the other 1/4 section functions as a **grow bed** filled with **soilless media** like gravel or expanded clay pellets for vegetable cultivation. Water from the fish tank is **manually fetched** from a basin/sump tank connected to the fish tanks through a tube with a valve and used to irrigate the plants. As the water percolates through the grow bed, it is naturally filtered removing solid waste and absorbing dissolved nutrients. The **cleaned water** then **drains slowly back** into the fish tank, maintaining a healthy aquatic environment without the need for mechanical filtration or pumps. The system is designed for **urban backyards**, requiring minimal space and no electricity. Its simplicity encourages **widespread adoption**, especially in low-resource settings. Additionally, the manual operation promotes **physical activity** and **community engagement**, while its low cost and water efficiency make it a sustainable solution for small-scale food production.

2.2 Operations

Water from the fish tank, rich in nutrients and organic waste, is manually fetched using a bucket or watering after it is let out into a basin (sump) can and poured over the grow bed to irrigate the plants. As the water filters through the media, it is naturally cleaned, solid waste is trapped, and dissolved nutrients are absorbed by the plant roots. The filtered water then drains slowly back into the fish tank through a gravity-fed outlet, completing the cycle.

2.3 Bill of materials and required tools

Table 1: Bill of materials

Item	Quantity*	Unit cost (GHS)	Total cost (GHS)
IBC tank	1	1600	1600
1 inch valve	1	30	30
4 inch valve	1	60	60
1 inch pipe	1	60	60
Chippings (one motorking or tricycle)	1	400	400
Pipe fittings (valve sockets, burns, thread tapes etc.)		50	50
Basin/sump bucket	1	120	120
1 inch tank connector	1	30	30
4 inch pipe	1	100	10
Total			2,360

Table 2: Tools required

Item	Quantity	Unit cost (GHS)	Total cost(GHS)
Hack saw	1	15	15
Glue small size	1	20	20
30 liter bucket	1	25	25
Total			60

3 Economics

3.1 Business model

The manually operated Chop and Flip aquaponics system offers a practical and sustainable solution for small-scale urban agriculture, serving as an ideal MVP within a lean business model. Built from an IBC tank, the system integrates fish farming and vegetable cultivation using soilless media, with water manually transferred from the fish tank to irrigate the plants and then allowed to drain back, naturally filtering waste and nutrients. This closed-loop design eliminates the need for electricity or complex machinery, making it highly accessible for low-income households, schools, and community groups. The system can be monetized through direct sales of kits, training workshops, and community-based franchising, with potential for subscription services offering seeds, fingerlings, and seasonal support. With minimal startup costs and a strong sustainability narrative, this aquaponics system is well-positioned to drive grassroots innovation in food security and urban resilience.

4 Future Improvements

4.1 SWOT analysis



Figure 4: SWOT – UDS LL – Manual Chop & Flip

Strengths

- Low-cost setup using repurposed IBC tanks
- No electricity required—ideal for off-grid use
- Dual production of fish and vegetables
- Water-efficient and eco-friendly
- Promotes physical activity and community engagement
- Compact design fits small urban spaces

Weaknesses

- Labor-intensive due to manual water transfer
- Limited scalability for larger operations
- Requires consistent human attention and care
- Vulnerable to user error in water quality management
- Limited automation may reduce appeal for tech-savvy users
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Opportunities

- Growing interest in urban farming and food security
- Potential for educational use in schools and NGOs
- Business model expansion via training, kits, or franchising
- Future upgrades with solar pumps or smart sensors
- Partnerships with local governments or community groups

Threats

- Weather extremes may affect system performance
- Lack of technical knowledge may hinder adoption
- Competition from commercial, automated systems
- Regulatory barriers or lack of policy support

4.2 Optimization

To optimize system, it's essential to directly address the weaknesses identified in the SWOT analysis. To reduce labor intensity, simple mechanical aids like hand-operated siphons or pulleys can ease water transfer, while scheduled routines with others can share the workload.

Scalability can be improved by modularizing the system adding more IBC units as needed and integrating low-cost solar pumps for semi-automation without compromising affordability.

To mitigate the need for constant attention, users can adopt basic water testing kits and visual indicators for pH and ammonia levels, ensuring fish health and plant performance. Educational workshops and illustrated guides can bridge knowledge gaps, empowering users to manage water quality and nutrient balance confidently.

Seasonal limitations can be addressed by selecting climate-resilient crops and using shading or insulation to regulate temperature. These targeted improvements preserve the system's simplicity while enhancing its efficiency, reliability, and appeal for broader adoption.

4.3 Threat mitigation

To mitigate threats, use climate-resilient crops and shade structures to handle weather extremes, and maintain strict hygiene to prevent fish diseases.

Provide basic training to users to reduce technical errors and promote consistent care. Collaborate with local authorities to navigate regulatory barriers, and emphasize the system's affordability and sustainability to stand out from commercial competitors. Building community support networks can also enhance resilience and long-term adoption.

5 Appendices

5.1 Photographs additional Documentation



Figure 4: Photos of onboarded participants operating manual Chop & Flip aquaponic systems