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EVALUATION OF FISH DEVELOPMENT IN CIRCULAR TANKS OF CEMENT PLATES WITH INTEGRATION TO PRODUCTIVE BACKYARDS

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ABSTRACT
The objective of this study was to evaluate the development of fish cultivated in circular tanks of cement plates, observing parameters such as growth rate, weight, health of organisms and economic viability of the practice. The study was carried out in the experimental area of Agrarian Diseases of the Federal Institute of Pará – Bragança Campus. The research involved a tilapia cultivation system in circular tanks of cement plates, with average diameters of 6 meters and depth of 1.30 meters in the central area. The tank was integrated into an urban productive backyard, with vegetable cultivation and an agroforestry system in the experimental area. Fish growth was monitored over six months, with periodic assessments of weight and length and parameters such as temperature, pH, dissolved oxygen, ammonia and nitrite will be monitored weekly, using appropriate analysis kits. The quality of the water was monitored to ensure adequate conditions for the cultivation of fish and to assess the impact of integration with the productive backyard. Variations in fish parameters and water quality were investigated by applying trend lines over time. These lines followed the linear and quadratic models depending on the fit to the data provided by the parameter R^2. The length of the fish increased over time, starting at an average of 19.5 mm and reaching an average of 28.7 mm. The weight of the fish increased throughout the experiment, with an initial average weight of 314.6 g and a final weight of 1,038.5 kg.

Keywords: Productive integration. Urban aquaculture. Sustainable production.

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INTRODUCTION

Aquaculture has been consolidated as a promising alternative for increasing food production, especially in urban and peri-urban contexts, where the demand for fresh and sustainable food grows every day. In this scenario, the integration of production systems, such as circular cement slab tanks, presents itself as a viable solution to maximize production efficiency and optimize the use of available resources. However, during the fish production process, the accumulation of organic and metabolic waste in pond tanks in water renewal systems is inevitable. These metabolites and nitrogen and phosphate compounds are diluted in water, and it is necessary to minimize the impact caused by phosphorus and nitrogen from fish farming effluents, one of the ways being the reuse of this effluent in the irrigation of various crops (Hussar, et al., 2002).

Circular tanks, due to their geometry, promote better water circulation and a more uniform distribution of nutrients, favoring the development of fish in controlled environments. When integrated into productive backyards, these systems enable synergy between different activities, such as horticulture and small animal husbandry, resulting in a sustainable approach that promotes food security and waste reduction. In the face of these challenges, integrated fish systems and productive agroforestry backyards can be a great alternative, as they significantly optimize aquaculture production and sustainability in the places where they are practiced. This is because the integrated process provides the recovery and reuse of resources such as nutrients and water in food production and the reduction of environmental pollution (Castellani & Abimorad, 2012).

As the 2030 Agenda for Sustainable Development presented guidelines on the eradication of hunger and other issues, constituting a strategic action plan for the achievement of economic, social and environmental development by the 193 countries that adhered to it. Among the seventeen sustainable development goals (SDGs) that make up the agenda, SDG-2 is to end hunger, achieve food security, improve nutrition and promote sustainable agriculture. According to Stédile and Carvalho (2017), the achievement of food sovereignty requires means to strengthen family farming with the production and circulation of products in local markets, reducing poverty and inequality in rural areas. In addition, the diversification of food production and the guarantee of supply in distant places consolidate and boost local economies. Thus, producing food sustainably is one of the paths to sustainable development. As fish farming has become an attractive and very promising activity, it requires more and more technical knowledge to maximize production (Bartz et al., 2018).

In this work, we sought to evaluate the development of fish cultivated in circular tanks of cement plates, observing parameters such as growth rate, weight, health of organisms and economic viability of the practice. In addition, the analysis of the interaction between the tanks and the productive backyards will be fundamental to understand the benefits and challenges of this integration, aiming at the formulation of recommendations for producers and farmers interested in adopting this innovative practice.

METHODOLOGY

The present study was carried out in the experimental area of Agrarian Diseases of the Federal Institute of Pará – Bragança Campus with the following geographic coordinates (Latitude 01°03'16.3"S; Longitude 046°47'05.7"). The study involved the tilapia cultivation system in a circular tank of cement slabs (Figure 1), with average diameters of 6 meters and depth of 1.30 meters during the months of October 2024 to January 2025. The tank was integrated into an urban productive backyard, with vegetable cultivation and an agroforestry system in the experimental area.

Figure 1. Circular tank with cement plates, 2024.

Source: Prepared by the authors themselves, 2025.

The water from the tanks was used to irrigate the plants. The species selected for cultivation was Nile tilapia (*Oreochromis niloticus*), due to its high adaptability and good response to intensive cultivation. The fish were acclimatized to the tanks for a period of 7 to

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10 days, to ensure that they are adapted to the new environment before the start of the experiment.

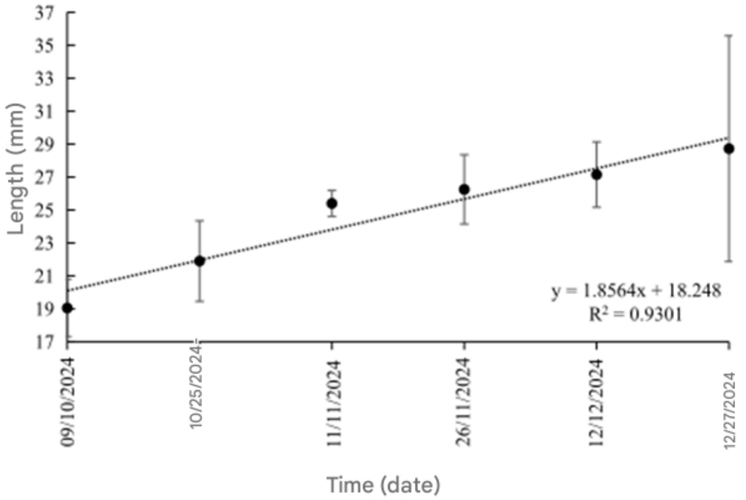
The diet was based on commercial feed, with the use of organic leftovers from local agricultural production (such as fruit and vegetable peels). Fish growth has been monitored over the months, with periodic assessments of weight and length and parameters such as temperature, pH, dissolved oxygen, ammonia and nitrite will be monitored weekly, using appropriate analysis kits. The quality of the water was monitored to ensure adequate conditions for the cultivation of fish and to assess the impact of integration with the productive backyard.

The water from the tanks was used to irrigate the plants in the productive backyard, taking advantage of the accumulated nutrients as natural fertilizer. Variations in fish parameters and water quality were investigated by applying trend lines over time. These lines followed the linear and quadratic models depending on the fit to the data provided by the parameter R^2.

RESULTS AND DISCUSSION

According to the results, the length of the fish increased over time, starting at an average of 19.5 mm and reaching an average of 28.7 mm in the period of the last measurement (Figure 2). The weight of the fish also increased throughout the experiment, with an initial average weight of 3.146 kg and a final weight of 10.385 kg for a sample of 20 fish.

Figure 2. Variation in the length of fish over time.



Source: Prepared by the authors themselves, 2025.

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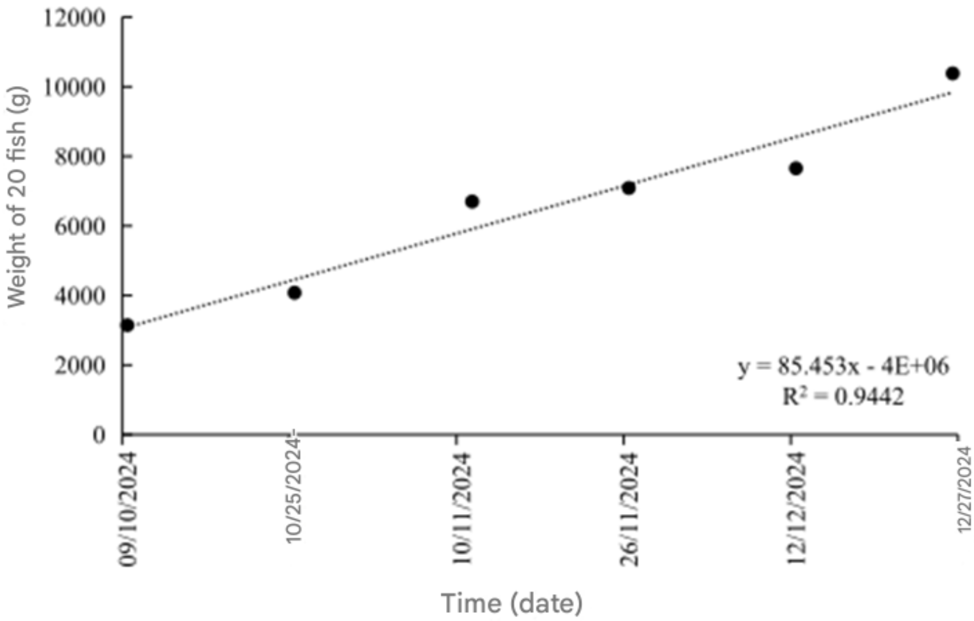
The observed growth results indicate that proper feeding management and water quality are crucial factors for the good performance of tilapia (Figure 3). Sanchez and Matsumoto (2012) highlight that water quality is essential to maximize zootechnical responses, such as fish growth, survival and reproduction, which reinforces the findings of this study, which demonstrated good fish growth in environments with water quality control. In addition, Yanbo et al. (2006) suggest that tilapia has better responses in brackish environments, due to the lower energy expenditure for osmoregulation, which may have contributed to the good growth performance in the present study.

Figure 3. Variation in the weight of 20 fish over time.



Source: Prepared by the authors themselves, 2025.

The water temperature ranged from 27.9 °C on the second day of measurement to 29 °C on the third and fourth days (Figure 4). This variable described a parabolic behavior, with growth in the first days of sampling and decrease in the last. According to Kubitza (2000), water temperature plays a fundamental role in the zootechnical performance of tilapia. To optimize the growth and feed conversion of the species, the ideal temperature should be maintained between 27 and 32 °C. Within this range, tilapia have better energy utilization, which results in faster weight gain and greater resistance to diseases. Due to the low variation of this temperature and the absence of values below 26 °C, the solubility of oxygen in the water was maintained at adequate levels, favoring the metabolism of the fish.

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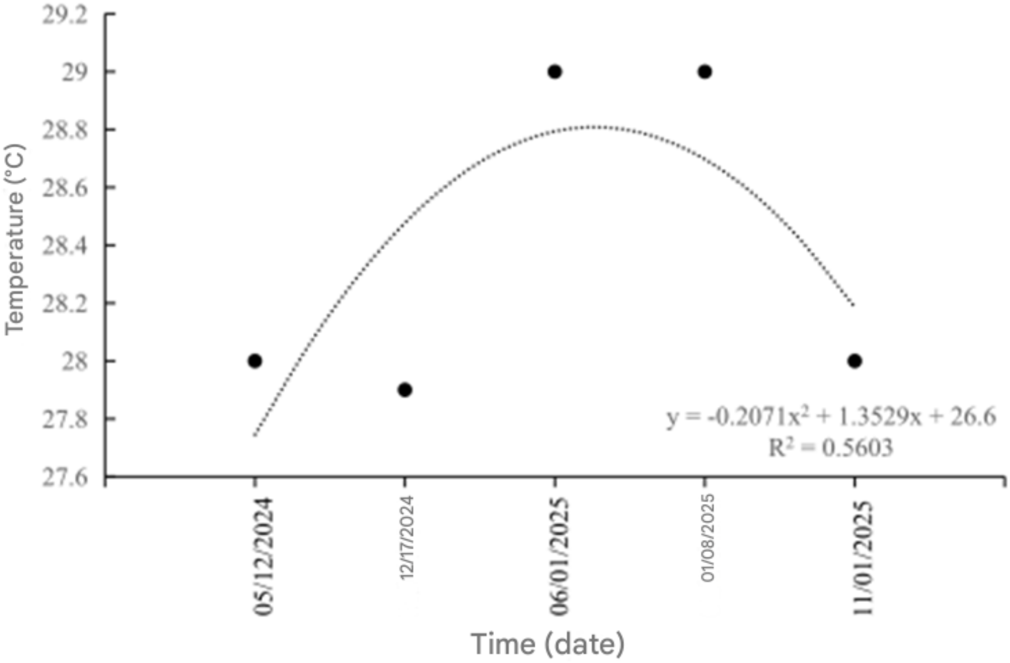
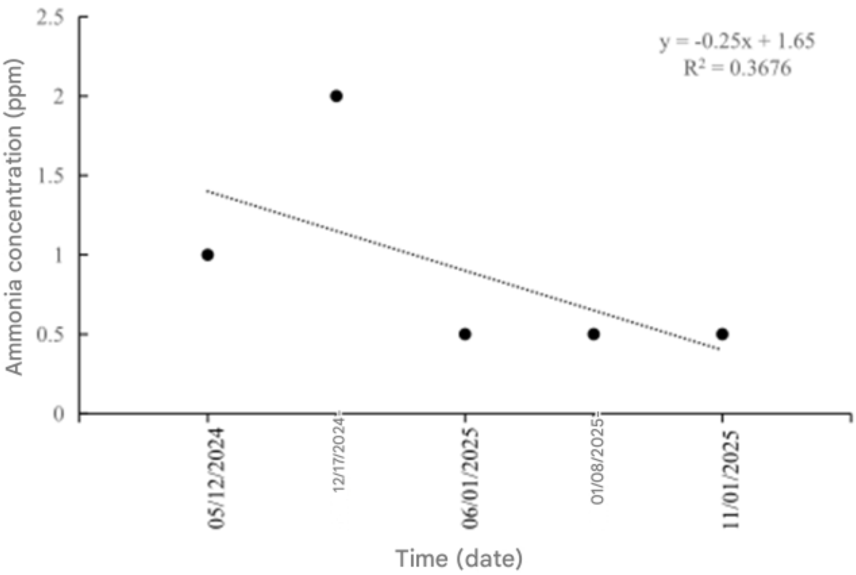
Figure 4. Variation of water temperature over time.



Source: Prepared by the authors themselves, 2025.

The ammonia concentration in the water peaked on the second day of sampling, then decreased and remained low until the end of the measurements (Figure 5).

Figure 5. Variation of the concentration of ammonia in water over time.



Source: Prepared by the authors themselves, 2025.

Ammonia is one of the most toxic compounds for aquatic organisms, and its control is essential to ensure good growth and survival rates. The increase in ammonia in the first

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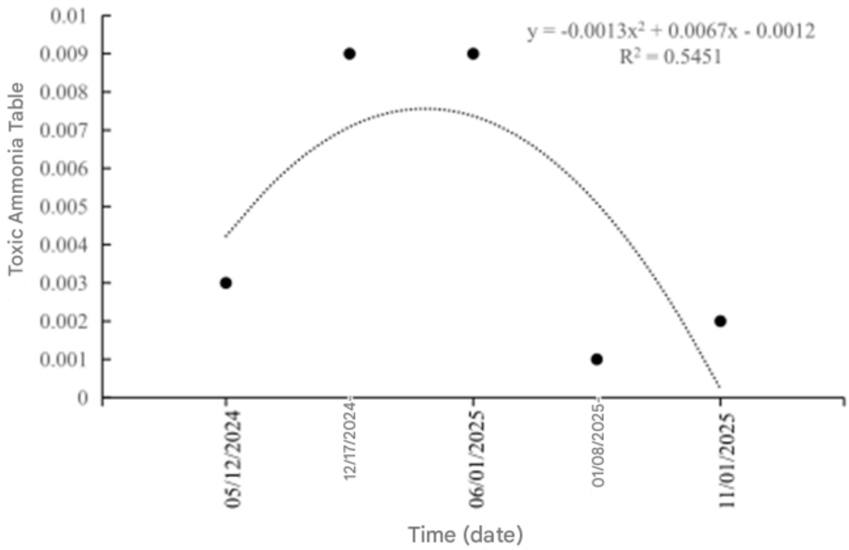
days of sampling is common, but its control throughout the experiment was adequate. According to the study by Moreira et al. (2001), tilapia tolerates higher levels of ammonia, which may explain the good growth performance observed, even with variations in ammonia levels. However, it is essential to ensure that the ammonia concentration does not exceed limits that could cause stress or death of the fish. The values in the toxic ammonia table varied parabolically over time (Figure 6). There was an increase in the values on the second and third days of sampling and a decrease in the last two days.

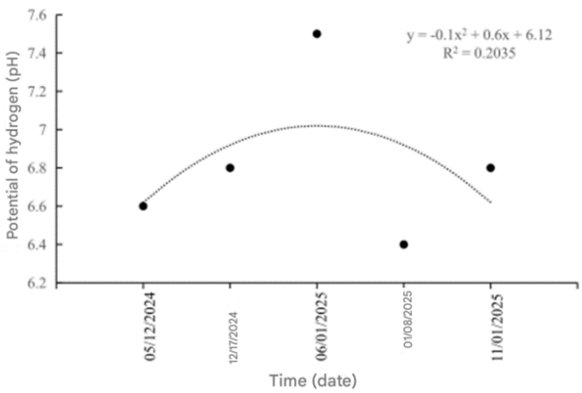
Figure 6. Variation in the values of the toxic ammonia table over time.



Source: Prepared by the authors themselves, 2025.

The pH varied parabolically throughout the study period (Figure 7). There was an increase in values in the first days, with a peak on the third day, and a decrease in the last two days.

Figure 7. Variation of the hydrogen potential (pH) in water over time.



Source: Prepared by the authors themselves, 2025.

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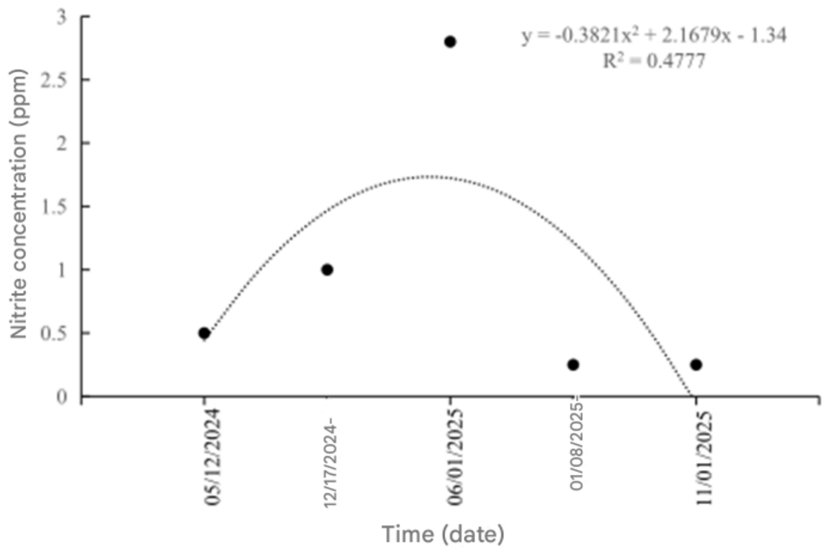
The nitrite concentration in the water described a parabolic variation over time (Figure 8). There was an increase in concentration in the first three days of measurement, with a peak on the third day, and a reduction in the last two days. pH and nitrites are influenced by the biological dynamics of the system and can be affected by factors such as feed, the presence of organic matter, and the amount of fish in the system (Sánchez and Matsumoto, 2012).

Figure 8. Variation of nitrite concentration in water over time.



Source: Prepared by the authors themselves, 2025.

Oxygen concentration decreased over time (Figure 9). The initial concentrations were 11 ppm and the final concentrations were 0.8 ppm. According to Taniguchi, Kato and Fontolan (2014), dissolved oxygen (DO) is essential for respiration and for the maintenance of the metabolism of aquatic organisms, and its concentration varies throughout the day. In cultivation systems such as cages, prolonged exposures to levels below 3 mg/L can impair the performance of organisms, which makes DO monitoring a critical variable. In this work, the variation of water quality parameters did not compromise the growth performance of fish in circular tanks.

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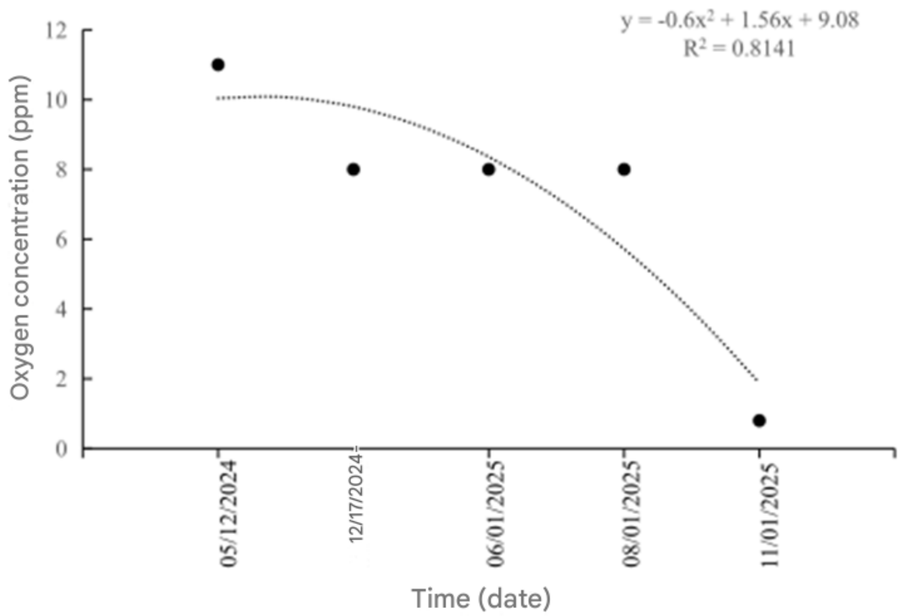
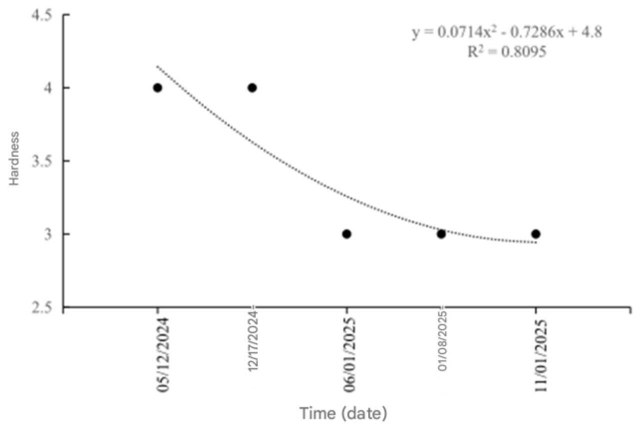
Figure 9. Variation of oxygen concentration in water over time.



Source: Prepared by the authors themselves, 2025.

According to Baldisserotto (2011), the total hardness of water is related to the presence of multivalent cations, such as calcium (Ca^{2+}) and magnesium (Mg^{2+}), which are the most common in freshwater environments. The variation in water hardness observed over time, which was initially 4 and decreased to 3, can be attributed to several factors, such as the dissolution of minerals present or variations in environmental conditions (Figure 10). The maintenance of this concentration throughout the experiment suggests that, despite the initial decrease, the water remained within acceptable parameters for fish cultivation. In aquaculture systems, hardness can directly influence the biochemistry of the water and, consequently, the performance of aquatic organisms.

Figure 10. Variation in water hardness over time.



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GENERAL CONSIDERATIONS

The integration of circular cement slab tanks with urban productive backyards has provided mutual benefits for agricultural production and fish farming. The use of water from the tank for plant irrigation helped to keep nutrient levels balanced, with ammonia and nitrite levels at 0.6 mg/L and 0.2 mg/L, respectively, within safe parameters for both fish and plants. The use of nutrients present in the tank water resulted in a continuous production of fruit trees in the agroforestry system, compared to non-irrigated areas, which indicated the effectiveness of the integrated system.

The economic impact of the system was positive, with the yield generated by the fish reaching an average of 15 reais per kilogram of fish. The total fish production was 500 fish with an average final weight of 1,038.5 kg. The combination of vegetable garden and fish production has largely offset the costs involved in operating the system, proving the financial viability of the project.

In terms of environmental quality, there were no signs of soil or water degradation around the tanks. The system proved to be sustainable, with the continuous and recycled use of natural resources, such as water used for irrigation, which contributed to the non-degradation of the local ecosystem.

Despite the benefits observed, the system faced challenges, such as limited space. The size of the tanks was insufficient for larger-scale production, which limited the expansion of the system. Based on these results, it is recommended to build larger capacity tanks or implement multiple interconnected tanks, which can optimize fish production. In addition, it is important to promote continuous training and training programs for families interested in production, with a focus on fish and vegetable garden management. This can improve the productivity and sustainability of the system, as well as strengthen marketing networks.

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