

Major Article

Malaria and fish farming in the Brazilian Amazon Region: a strengths, weaknesses, opportunities, and threats analysis

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Abstract

Introduction: The fish farming program in Acre is as an alternative program to generate income and employment and has promising regional, national, and international markets. While the economic importance of fish farming in the Juruá Region is clear, one must address its contribution to increase malaria transmission. **Methods:** This was a qualitative study. The answers of the 16 key informants were organized into the following: (1) the healthcare services structure; (2) conscience, perception, and behaviors; and (3) socioeconomic and political issues. Each answer was classified as weaknesses, strengths, opportunities, and threats. **Results:** Regarding healthcare services, the frequency of household visits was reduced, and subjects presenting with malaria symptoms were required to visit a healthcare unit to be diagnosed and treated. Regarding individual's conscience, perception, and behavior, malaria was considered an insignificant disease, and a large proportion of the population were engaged in health practices that put them at risk in contacting with malaria vectors. Regarding political and economic issues, there were economic and infrastructure barriers for the development of a productive activity, and the insufficient credit or formalization of their properties prevented their access to governmental incentives and the financial market. **Conclusions:** Support to fish farmers for low-cost inputs was not observed, and appropriate knowledge regarding the impact of the absence of maintenance and abandonment of fish tanks was insufficient. Moreover, insufficient healthcare services prevented not only the treatment of individuals with malaria but also the control of this disease.

Keywords: Malaria. Communicable Diseases. Fish Farming. SWOT analysis.

INTRODUCTION

Within the Brazilian Amazon region, 5% (37) of the municipalities are responsible for reporting 80% of all malaria cases in 2013¹. Four of them are located in the Alto Juruá region, State of Acre, including Cruzeiro do Sul, Mancio Lima, Rodrigues Alves, and Tarauacá.

In recent decades, the Brazilian government has financially invested in fish farming in the Amazon region. This action, as an alternative for generating income and employment, has promising regional, national, and international markets. The high daily consumption of fish by the local population and the

export of fish to other Brazilian states and even to other countries are potential markets to be explored^{2,3}.

In the early 2000s, the Government of the State of Acre, northern Brazil, initiated a state-level program for the development of fish farming. This program involved the creation of a complete production chain, organized around two poles: the Vale do Juruá Pole, equipped with a fingerling production center and a cold store facility, and the Vale do Acre Pole (**Figure 1**), equipped with a fish food pellet factory, a technical center for fingerling production, and a large cold storage facility⁴. A third facility located in Rio Branco, the state capital, contained an industrial fish farming complex and a public-private company named Fishes from Amazônia S/A⁵. Between 2013 and 2015, US\$ 21 million was invested in the Rio Branco Complex, and new investments of US\$10 million are estimated up to 2018⁶. In July 2016, the complex received authorization from the Ministry of Agriculture, Livestock, and Supply to export fish meat to

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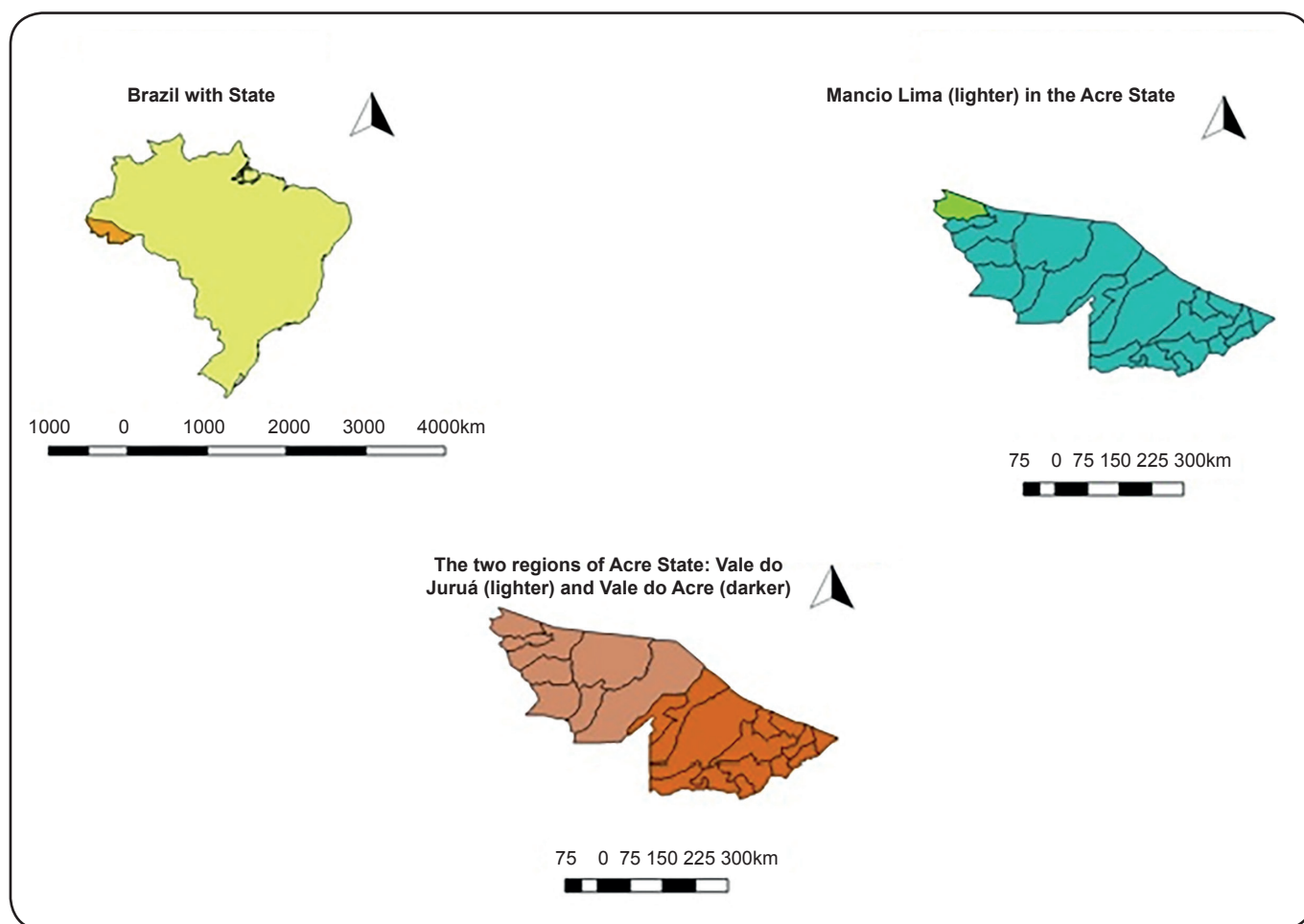


FIGURE 1: Municipality of Mancio Lima, State of Acre, Brazil.

any country as the “Fish of the Amazon” met the requirements of the respective regulatory agencies. Meanwhile, a second public-private company, the Juruá Fish S/A, has managed the entire fish sector in the Juruá Valley (initially, this project had an investment of US\$ 4.5 million)⁷.

The association between *Anopheles* population and the fish farming ponds in malaria endemic areas is observed worldwide since the change in the water pattern and formation of water bodies as a result of fish farming, when performed in areas endemic for malaria, can contribute substantially to the increase in its incidence⁸⁻¹⁴. In these areas, fish ponds characterized by shaded, deep, clean waters and surrounded by vegetation, without fishes or without consistent cleaning of their borders, form suitable breeding sites for *Anopheles darlingi*^{15,16}, thus contributing substantially to the increase in the incidence of malaria. According to a previous study, Reis¹⁷ found that these types of fish ponds are prevalent in the Municipality of Mancio Lima, including its urban areas.

While the economic importance of fish farming in the Brazilian Amazon region, and the Juruá Region in particular, is clear, one must address its contribution to increase malaria transmission. Malaria has caused a large burden to the population; its control results in high costs, and considering

the insufficient specific solutions to treat malaria, the country’s efforts toward malaria elimination is jeopardized.

In this scenario, the present study aimed to analyze the association between fish farming and malaria in this hot spot of malaria at the northern region of Brazil from the ecosystem approach^{18,19} to provide information to subsidize the development of malaria control program for fish farming.

METHODS

This was a qualitative cross-sectional study based on an ecosystem approach, using strengths, weaknesses, opportunities, and threats (SWOT) analysis, to understand the association between the implementation of the policy to encourage fish farming in the State of Acre, Brazilian Amazon, and the occurrence of malaria.

Study Area

The study was conducted in the Municipality of Mancio Lima (Figure 1), in the northwestern state of Acre, in the Alto Juruá region, Brazil. Mancio Lima has an estimated population of 17,910 inhabitants (in 2017) and an area of 5,453,073 km largely occupied by the Amazonian forest^{20,21}. In 2010, the population was 15,206 individuals (9,777 literate, representing

64.30% of the total population), 7,836 men (51.53% of the total population) and 7,370 women (48.47%) and 3,589 households, of which 2,169 are living in the urban area and 1,420 in the rural area. In that same year, its Human Development Index was 0.625, ranking 3,580th in Brazil among 5,565 cities²².

Mancio Lima is a low-income municipality. In 2015, the population had an average monthly per capita income of 1.6 minimum wages. Additionally, 48.7% of the population had a monthly per capita income of up to half a minimum wage. The employment situation is also critical. Approximately 4.5% (783 people) of the population had formal work. Only 8% of the municipality has an adequate sewage, and 4.7% of urban households are on public roads with adequate urbanization (with sewers, sidewalks, pavements, and pavements)²².

The municipality has been engaged in fish farming as an economic activity since 2001 with the participation of several institutions such as the Department of Agriculture and Livestock of Acre, the Acre Micro and Small Business Support Service (SEBRAE/AC - Serviço Brasileiro de Apoio às Micro e Pequenas Empresas do Acre), and the Association Manciolimense of Pisciculture, besides the Government of the State of Acre. The fish farmers have a private feed factory and a center for the production of fingerlings in a public-private partnership²³.

Data collection and analysis

In July and August 2016, 16 key informants, described below, were interviewed. The goals were to describe the fish farming situation in Mancio Lima and to determine the association between the activities performed in fish farming and the evolution of malaria transmission.

Based on the theoretical-methodological framework of the ecosystem theory^{18,19}, the questionnaires for interviews were elaborated. This was the basis for analyzing the associations between the process installation of fish farming in the territory and malaria transmission in Mancio Lima. According to Santos and Augusto¹⁹, four dimensions or moments of the process of social reproduction can produce the territorialization process: biological reproduction, ecological-political reproduction, reproduction of self-consciousness and behavior, and techno-economic reproduction. These dimensions guided the construction of the matrix of SWOT. Using SWOT analysis, we described the strategies for reducing and/or controlling the risk of malaria. The results were initially divided into three major blocks: (1) healthcare services structure, (2) consciousness and conduct of the local population, and (3) socioeconomic and political characteristics. The questionnaires were pretested aimed at language adequacy.

Key informants belonged to two major categories, those belonging to institutions involved in fish farming and/or malaria control service in the region and those representing small, medium, and large fish farmers. For the first group, 16 key informants were interviewed. They represented the following institutions or social groups: Secretary of Health of Mancio Lima, Secretariat of Agriculture and Livestock of

Cruzeiro do Sul, Cooperativa de Pescadores de Mancio Lima (Cooperpeixe), Acre Environment Institute of Cruzeiro do Sul, and some cooperatives.

To identify fish farmers who could act as key informants, the representatives of the Mancio Lima fish cooperative were consulted and asked to identify small, medium, and larger farmers who had a certain social standing, with a wide network of relationships, and, therefore, who were able to represent the collective views.

The exclusion criteria of the informants were as follows: not a fish farmer or not a resident in the region, a fish farmer or local resident for less than a month, fish farmers who did not own a fish pond, and less than 18 years old. Individuals provided informed consent for inclusion in the study.

Through the interviews, the following information were obtained, when applicable: the time they started fish farming and joining cooperatives, roles of cooperative, procedures to be performed to become a cooperative fish farmer, pond licensing processes, pond registration processes, acquisition of fuels, transport of production, hiring of technicians and support team, supply of inputs for the fish farming activity, construction of improvements to the fish farming activity (fingerling production, fish food pellet factory, fridge, vehicles, general equipment), fiscal and financing incentives, provision of technical and vocational courses, and federal government participation in the implementation and expansion of fish farming in the state. These were investigated based on open questions without predefined answers to obtain all possible answers for each subject described above.

The SWOT matrix was built with the most relevant issues to assess the association between fish farming and the occurrence of malaria. The strengths (internal forces of the system, providing stability, security, and coherence), the weaknesses (factors that create barriers to system development), the opportunities (external factors that reinforce the development of competitive advantage), and the threats (adverse trends for external development) were taken into consideration²⁴.

The study was approved by the Research Ethics Committee of the National School of Public Health Sergio Arouca, Oswaldo Cruz Foundation (Protocol Number: 54085216.7.0000.5240).

RESULTS

The answers of the 16 key informants were organized into three domains: (1) healthcare services structure; (2) conscience, perception, and behaviors; and (3) socioeconomic and political issues. Within each of these domains, elicited themes were classified as weaknesses, strengths, opportunities, and threats, considering the goal of developing a fish farming program without malaria. The resulting SWOT matrix is shown in [Supplementary data (Table 1)].

Healthcare services: Most informants reported a reduction in the frequency of household visits by healthcare personnel in recent years. These visits were important as a method to increase the detection and treatment of malaria cases and an

opportunity to promote preventive behaviors, such as the use of bednets and the avoidance of outdoor activities in the evening. Recently, subjects with malaria symptoms are required to visit a healthcare unit to be diagnosed and treated. On the positive side, informants declared that the number of medical doctors in the region has increased as a result of the federal program “Mais Médicos” that offers incentives to Brazilian and foreign medical doctors to visit the remote areas in the Amazon.

Individual’s conscience, perception, and behavior: Most informants agreed that the population does not consider malaria as a serious problem in their lives. This is attributed to its commonness. The majority of the population knows how malaria is acquired, the importance of avoiding bites from mosquitoes, and the importance of cleaning the borders of fish ponds. However, this knowledge does not translate into practices, and several individuals do not adhere to these preventive practices. It is observed by the informants that a large proportion of the population has habits that put them at risk in contacting with malaria vectors, such as entering the forest for work or leisure, bathing in streams, and performing outdoor activities during the evening when mosquitoes are significantly widespread.

The informants also reported the presence of fish farmers who do not follow good farming practices, which include removing the vegetation from inside the pond and the border.

Political and economic issues: There are economic and infrastructure barriers for the development of a productive fish farming activity in this region. Local farmers do not have financial capital to invest in their farms and among the inputs required for farming, and all informants considered purchasing fish food as significantly expensive.

Insufficient credit or formalization of their properties prevents their access to governmental incentives and the financial market. Several farmers receive social allowances, suggesting that their production is insufficient to take them away from the poverty zone. The informants also perceived a lack of investment by the federal and local governments to improve the fish production chain and initiatives to facilitate farmers to acquire a Certificate of Origin, which would allow them to explore the external markets.

In summary, insufficient equipment for farming and technical assistance were predominantly observed during the study. Equipment for digging ponds and their maintenance and the transportation of inputs are significantly required. The local government has some equipment that could be borrowed, but maintenance has been an issue.

The organization of fish farmers in a cooperative is considered as an important initiative to increase their power when negotiating prices and dealing with the local government. Only a proportion of fish farmers is member of a cooperative. Some informants complain that nonparticipants are “individualistic” and skeptical of cooperating initiatives. One respondent attributed this behavior to the “time of rubber extractivism” when labor was a solitary activity.

DISCUSSION

Since 2014, Brazil has been experiencing political and economic crisis. This crisis has significantly affected the public services, increased social vulnerability, and jeopardized the control of diseases²⁵. The prize-winning Acrean malaria control program, before the crisis, relied strongly on house-to-house detection, search of asymptomatic infections, supervised treatment, and delivery of bednets. In 2015, these activities were drastically reduced. The lack of household visits was perceived by the key informants as a threat to the control of malaria, requiring sick individuals to visit a healthcare unit for treatment at a significant cost due to the distances involved. As a consequence, several sick individuals gave up treatment or delay it, leading to the aggravation of symptoms and the maintenance of transmission by symptomatic and asymptomatic cases²⁶⁻²⁸.

Most individuals have some knowledge on how the disease is transmitted, the importance of protecting themselves from mosquito bites, and the risks posed by the presence of fish ponds without maintenance. These are important assets for a fish farming malaria control program. On the contrary, there is an overall perception that malaria is not a severe threat. This perception can interfere with the adherence of the population to preventive behaviors such as using bednets and avoiding outdoor activities during the dusk and early evening when anopheline mosquitoes are more active. Studies have identified that the lack of confidence on the benefits of bednets is associated with low usage²⁹. Besides the use of bednets, avoidance of mosquito bites is a challenge for most of the population who live in houses made of wooden boards, with crevices³⁰. These houses often lack indoor bathrooms and kitchens; hence, householders have to fetch water in water sources where they are exposed to mosquito bites.

Cleaning the borders of fish ponds and removing those that were abandoned have a direct impact on the abundance of anophelines and, consequently, on the risk of malaria transmission³¹. Abandonment of fish ponds often occurs because the owners lack the capital and/or technical knowledge to obtain the desired productivity. Fishes need to be fed for months, and in Alto Juruá, the inputs for fish farming, specifically the fish food, are very expensive. The informants mentioned that the construction of a local fish food plant would reduce the costs. Moreover, it would be beneficial to develop new food formula that utilizes local nutrients instead of soybean. This would make the fish food cheaper, contributing to the local economy³². For several farmers, a barrier for obtaining financial capital is the lack of SIF (Serviço de Inspeção Federal) Certification.

In the study area, some of the fish farmers are members of a cooperative that negotiates better prices for acquiring inputs and providing technical support. There is an opportunity for integrating health promotion actions within cooperative activities, including the association between malaria prevention and fish farming material³³.

Our results show that regardless of the evident relevance of fish farming to the population and of the financial investments for the installation and maintenance of the entire fish production chain, considering the political and financial crisis in the country during

the study, the basic quality services were unsatisfactorily offered to the population. We observed that the government has insufficient support to fish farmers for low-cost inputs and there is insufficient transmission of knowledge about the impact of inadequate maintenance and abandonment of fish tanks for malaria. Moreover, insufficient healthcare services prevents not only the treatment of people with malaria but also the control of this important disease.

Fish farming influences malaria transmission in Mâncio Lima mainly through abandoned tanks, the lack of integration between the three spheres of the government, the fact that not all fish farmers clean the tanks, the high feed price, the low educational level, and the decrease in home visits by healthcare personnel. All these factors tend to increase the transmission of the disease in Mâncio Lima as they would contribute to increased water collections, increasing areas favorable for the reproduction of anophelines.

Thus, a public-private community alliance in the Juruá Valley is suggested, with the intention of absorbing the production that already exists in the region. It is also necessary to create a unique registry for fish farmers, integrating the three spheres of the government, facilitating the acquisition of SIF by producers. In this way, the lack of vehicles and equipment, technicians, and information can be solved through investments in machinery and training of fish farmers, who often abandon fish production because of high investment cost. Better regionalization of public healthcare services in the Juruá Valley is also necessary, through the redistribution of health funds to the municipalities of the region, which could be better distributed among them.

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Conflict of interest

The authors declare that there is no conflict of interest.

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