

TILAPIA POTENTIAL IN PERU

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Tilapia is a species of tropical waters native to Africa and the Middle East, and the dissemination of its cultivation in the world is mainly due to its easy adaptation to captivity, tolerance to high densities, disease resistance, filter feeding and omnivorous feeding habits, acceptance of diverse varieties of food, white flesh and the possibility of offering quality fillets. This has given tilapia an important commercial presence, making it one of the most widely cultivated aquaculture species worldwide.

Tilapia is grown in more than 100 countries and about 98 percent of the tilapia produced in these countries were introduced into them. The most common species of tilapia in the world is Nile tilapia, representing approximately 75 percent of the production of cultivated cichlids.

The world production (fisheries and aquaculture) of tilapia was 6.5 million t, of which 5.9 million t were from aquaculture, with 3.9 million t from Asia in 2014 (FAO 2016). Global tilapia production has been projected to almost double from 4.3 million t in 2010 to 7.3 million t per year in 2030 (World Bank 2013).

In 2014, aquaculture in Latin America and the Caribbean reached 2.8 million t (FAO 2016), of which tilapia contributed 406,000 t, ranking third after salmonids and penaeid shrimp. The main producing countries in the region are Brazil (48.8 percent), Colombia (14.3 percent), Mexico (13.4 percent), Honduras (7.3 percent), Ecuador (5.8 percent), Costa Rica (4.1 percent), Guatemala (2.3 percent) and Peru (1.1 percent), accounting for 97.5 percent of tilapia production in the Latin America and the Caribbean region (Table 1). This article presents an analysis of the current state of tilapia culture and its prospects and potential in Peru.

AQUACULTURE IN PERU

Aquaculture in Peru is in full development due to the country's comparative advantages such as climate and abundant water resources. Aquaculture production has increased from 6,664 t in

TABLE 1. TILAPIA PRODUCTION (t) IN THE MAIN PRODUCING COUNTRIES OF THE LATIN AMERICA AND CARIBBEAN REGION (SOURCE: FAO 2016).

Country	Year		
	2012	2013	2014
Brazil	182,297	169,306	198,664
Colombia	52,688	57,000	58,500
México	23,749	29,269	54,536
Honduras	20,500	22,600	29,750
Ecuador	39,820	23,922	23,902
Costa Rica	23,355	26,401	16,736
Guatemala	5,455	5,974	9,546
Perú	3,174	3,840	4,610

2000 to 120,570 t in 2015. The growth of Peruvian aquaculture was 20 percent from 2000 to 2009 and 11.6 percent from 2006 to 2015. The greatest production volumes are of trout (45 percent; around 41,000 t in 2015), shrimp (26 percent), fan shell (24 percent) and tilapia (4 percent) (Fig. 1). About 3,250 t of Nile tilapia were produced in 2015.

THE CULTIVATION OF TILAPIA IN PERU

In the 1960s, the Directorate General of Hunting and Fishing of what was the Ministry of Development and Agriculture made the first introductions of *Tilapia rendalli* as forage for paiche *Arapaima gigas*. In the 1970s, the Peruvian Sea Institute (IMARPE) and the National Agrarian University La Molina (UNALM) introduced *Oreochromis niloticus*, *O. hornorum* and *O. mossambicus* (Ramos and Gálvez 2000) for research and cultivation in the tropical

and temperate zones of the Amazon and the Peruvian coast. Blue tilapia *O. aureus* were introduced in the mid-1980s.

The first experience with fertilized egg collection and embryo incubation in hatcheries began in 2000, carried out at the former Tambo de Mora Aquaculture Center of the National Fisheries Development Fund (FONDEPES), which was later consolidated in 2005 with the start of the first tilapia hatchery in Peru. Cultivation has spread in the high forest and on the northern coast, linked to the use of ponds and more recently cages. There are several opportunities in these areas and, with the available culture technologies, are indications of good prospects to produce this species, although business organization and access to markets must be improved.

Tilapia has easily adapted to tropical conditions in the country, mainly in the north (Department of Piura) and in the high forest

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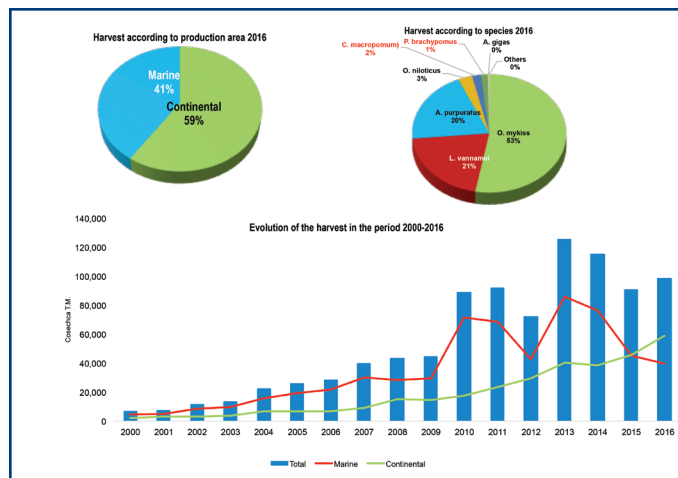


FIGURE 1. Aquaculture production in Peru by area and year (Source: RNIA 2016).

(Department of San Martín, mainly in the provinces of Tarapoto, Moyobamba and Rioja). Nile tilapia is distributed along the Peruvian coast from Tumbes to Tacna, as well as in several Amazonian regions where aquaculture with limited resources and of micro and small companies predominates. The greatest production is concentrated in Piura (67 percent), San Martín (27 percent) and Lima (6 percent), and the lowest in Cajamarca, Amazonas, La Libertad and Madre de Dios (1 percent) (Fig. 2). According to the area where they are harvested, production in the coastal zone (73 percent) is greater than the high forest (27 percent) (Fig. 2).

The actual production of tilapia is underestimated by official statistics because there is high informality in the sector, especially in the Amazonian areas, and therefore accurate information is not obtained by the national statistical information collection systems that are administered by the Ministry of Production and collected by regional governments. All statistics are derived from information officially reported by aquaculture companies, small producers and directorates of regional governments.

Tilapia production is still modest, although there has been a rapid increase from just 46 t in 2000 to 3,250 t in 2015. The largest crop registered was 4,610 t in 2014 (Fig. 3). Tilapia production grew at an annual rate of 7.2 percent from 2007 to 2015. The low production of tilapia in 2015, according to information provided by producers in San Martín, has been caused by the lack of an adequate supply of seed with appropriate conditions for the crop.

In 2015, the Ministry of Production registered 389 formal aquaculture establishments of which 58 percent were subsistence, 39 percent small-scale, 1 percent large-scale, 0.8 percent oriented

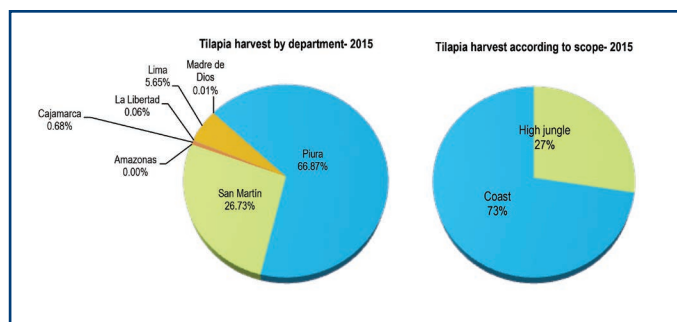


FIGURE 2. Main departments where tilapia is harvested (Source: PRODUCE-RNA statistics).

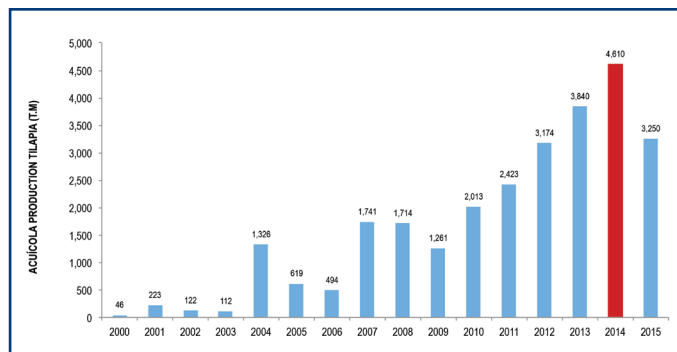


FIGURE 3. Evolution of tilapia crops 2000-2015 (Source: RNIA 2016).

to seed production and 0.5 percent is small-scale with seed production. Based on this information, it has been estimated that tilapia aquaculture in Peru has generated 2,169 direct jobs and 5,145 indirect jobs (Table 2). Considering that each job can support an average of three dependents, it is estimated that formal tilapia aquaculture would be a means of supporting about 30,000 people. According to the San Martín Regional Aquaculture Plan 2014-2023, there are around 740 informal aquaculture establishments in San Martín, doubling the number of formal establishments nationwide (Mendoza 2013).

AVAILABLE TILAPIA STRAINS AND SEED PRODUCTION

Currently the species cultivated in different parts of the country are *O. niloticus* (the entire coast, San Martín, Jaén, Tingo María, Madre de Dios), *O. niloticus* Chitralada strain (Piura, Tarapoto, Rioja, Moyobamba, Jaén, Tingo María), red tilapia (Jaén, Lima and Ica), all-male hybrid *O. aureus* ND-41 (Piura and San Martín), and *O. urolepis* hornorum (San Martín and Cajamarca).

The main farms that are located in Lima and Piura use blue tilapia and Nile tilapia of the Chitralada strain, in general of good genetic quality. However, small producers located in Cajamarca and San Martín produce and use Nile tilapia seed of very low quality, with varying degrees of degeneration and low yield. It is necessary to make an effort to assure an adequate production of quality seed with high performance potential, responding to the needs of producers and adapted to each geographic condition and business situation. Production techniques and seed quality must be improved.

The technique of fry production that is the most practiced in Peru is the use of reproduction ponds and hapas. Ponds are usually

TABLE 2. ESTIMATION OF JOBS GENERATED BY TILAPIA CROPS (2015) IN PERU (SOURCE: MENDOZA 2011).

Level of development	Nº of rights granted (a)	Nº of employed persons (Average) (b)	Direct Employment (axb)	Nº of indirect jobs (c)	Indirect Jobs (axc)	Total
Larger scale	4	40	160	120	480	640
Seed production	3	5	15	15	45	60
Reduced scale/seed production	2	5	10	15	30	40
Smaller scale	153	10	1,530	30	4,590	6,120
Subsistence	227	2	454	-	-	454
Total	389		2,169		5,145	7,314

TABLE 3. MAIN HORMONES USED FOR SEX REVERSAL OF TILAPIA IN PERU.

Hormone	Origin	Purity (percent)	Sex reversal efficiency (percent)	Price (S/.)
17alpha- methyltestosterone	China	99.8	95-98	363.64
17alpha-methyltestosterone	Brazil	90.8	85-90	181.82
mesterolone	Germany	99.8	98	545.45

TABLE 4. TILAPIA IMPORTS TO PERU FROM VARIOUS COUNTRIES BY VALUE (EXPRESSED AS FOB IN THOUSANDS OF US DOLLARS) AND NET WEIGHT (IN t) (SOURCE SUNAT IMPORT INFORMATION, SEPTEMBER 2016).

Product type/origin	FOB Value (US\$)					Net weight (t)				
	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
Frozen										
China	2,938.04	5,721.42	8,404.43	5,401.49	5,675.63	849.24	1,601.36	2,086.32	1,551.44	1,844.99
Vietnam	69.31		161.45	399.29	190.75	21.92		42.02	118.00	61.00
United Kingdom					76.03					24.00
Ecuador	78.39	101.93	37.80	42.05	12.60	11.26	13.60	4.23	4.59	1.36
United States		110.13					19.07			
Canada		2.00					3.00			
Fresh										
Ecuador	2,259.82	1,927.65	1,508.66	1,679.53	1,047.18	308.33	243.14	178.50	190.59	118.49
China		105.80	469.17				20.00	80.70		
Colombia		12.89	101.38				1.40	12.18		
Frozen Fillet/Whole										
China	93.05		109.37	324.54	68.18	21.50		21.32	66.18	22.00
Ecuador	42.32		21.80			5.67		2.50		
Colombia		120.82	279.37				14.76	33.83		
Grand Total	5,480.92	8,102.63	11,093.43	7,846.89	7,070.37	1,217.92	1,916.32	2,461.59	1,930.79	2,071.84

small (100-5000 m²) and are managed with fertilization, control of physical-chemical parameters of the water, use of extruded feed and a sex ratio of three females to one male. Fry are collected from ponds with nets periodically (daily, weekly or biweekly). There are also some hatcheries for reproduction, incubation and nursing that are used only by companies with higher levels of investment and that have recirculating systems, incubators, biofilters and disinfection systems with ultraviolet light.

Fry marketed for cultivation in the indicated departments are mostly male monosex and come mainly from private and state companies. There are more than 30 hatcheries that produce sex-reversed male fry and fingerlings, of which only four are formally registered. Among the regions where sex reversed fry are produced and of which the clear majority are not authorized, there are more than ten producers in San Martín and between one and two producers each in Chincha, Tingo María and Jaén. Hormones most commonly used in the process of sex reversal from females to males are 17-alpha methyltestosterone and mesterolone. These are commonly found in local markets and have different provenances, costs and levels of purity (Table 3).

GROW-OUT SYSTEMS

Tilapia are produced in monoculture or polyculture in earthen or concrete ponds and rarely in cages, and are supplied with high-quality feed. In Peru, the most common tilapia production methods are:

- Extensive, where tilapia are stocked as mixed-sex fry and at a low density in earthen ponds, which are usually managed by families that grow fish for household consumption or local marketing;
- Semi-intensive, which uses sex-reversed fry, fed with balanced feed and water is fertilized with organic or inorganic fertilizers to provide supplementary natural foods and improved water productivity;
- Intensive, where sex-reversed fry are used. Greater stocking densities are managed, and high-quality balanced feed is used, where the natural productivity of the environment plays a secondary role, contributing in some cases to improved feed conversion.

In terms of infrastructure and equipment, ponds are commonly used and to a lesser extent floating cages and lined tanks, and recently ponds with recirculation systems and paddlewheel aerators.

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Similarly, there are some experiences in the development of aquaponic crops based on the production of tilapia that can improve the profitability of crops, such as those carried out at the Aquaculture Research Center of the Universidad Científica del Sur (Baltazar *et al.* 2015).

In the department of San Martín, most producers are small scale and their level of technification in tilapia culture is low and in many cases at the subsistence level. However, in the departments of Piura and Lima, tilapia culture has been developed with a higher level of technology and good seed quality. This technology for seed production and fattening has not been extended yet. Government agencies intend to extend technological development to small and medium producers, understanding the development potential of aquaculture in general. However, Peruvian legislation has regulated the expansion of tilapia culture, limiting development to the Peruvian coast and in those departments that have a management plan for tilapia culture approved by the Ministry of Production and regional (departmental) governments. In this context, currently tilapia culture in the Amazonian area is only authorized in the department of San Martín.

MARKETING

Around 90 percent of all registered tilapia production is destined for the domestic market and 10 percent goes to the export market, mainly as fresh fillets destined for the USA, with a smaller volume to markets in Ecuador, France, Taiwan and Chile. In 2015, these exports had a value of US\$ 2.6 million. Imports of tilapia to Peru have doubled between 2012 to 2016 from 1,218 t to 2,072 t, mainly as frozen fillets from China and whole fresh slices from Ecuador (Table 4).

The evolution of the domestic market of tilapia produced in the country has increased from only 46 t in 2000 to 2,927 t in 2015, which is 33 percent less than the peak in 2014. Tilapia represents 5 percent of the total domestic sales of aquaculture products, with an estimated first sale value of US\$ 6.2 million for the domestic market (Fig. 4).

Many departments in the country have the conditions to develop tilapia cultivation, which by the ease of cultivation and easy access to local markets, could contribute to the local and regional development

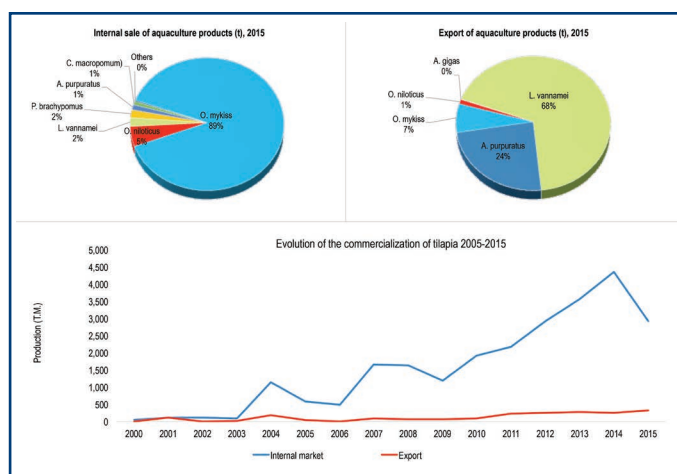


FIGURE 4. Marketing of tilapia in the domestic and export markets (Source: RNIA 2016).

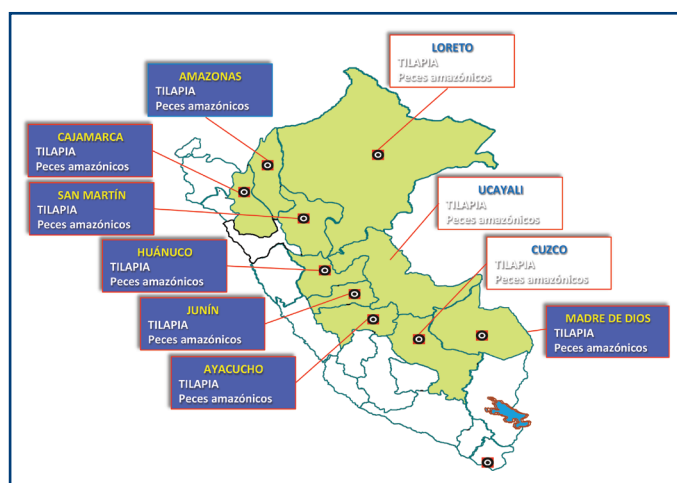


FIGURE 5. Departments in the Peruvian Amazon where tilapia are grown.

of each area, in addition to contributing to food security and reducing poverty. Although tilapia is currently only authorized for cultivation on the coast and in the San Martín region, there are already initiatives to be able to manage the authorization of its cultivation in other regions of the Peruvian Amazon, mainly due to requests by fish producers who are aware of its great potential there.

TILAPIA PRODUCTION IN THE PERUVIAN AMAZON

Tilapia culture in the Amazonian zone of Peru is authorized in the department of San Martín through a management plan for the cultivation of tilapia. The area is popularly known as Selva Alta, Ceja de Selva, Montaña or Monte, and is characterized by dense, rainy and cloudy mountain forests to the east of the Peruvian Andes. It starts between 500 and 600 m above sea level, where the Amazonian plain ends and the mountains begin to rise. The high forest can reach an

altitude of more than 3,000 m above sea level in the most humid areas or a much lower altitude where it borders dry inter-Andean valleys.

Tilapia culture in the different zones of the Peruvian Amazon is a mixture between subsistence and semi-intensive approaches and is carried out at stocking densities of 3-10/m². Producers using both approaches consume tilapia directly or market their crops in local retail markets and restaurants. Those using semi-intensive methods market crops in most cases to restaurants, or in some cases send their products to other locations live or eviscerated and refrigerated. These farm fish use ponds between 3-10 ha.

There are five Amazon departments (Amazonas, Loreto, San Martín, Ucayali and Madre de Dios) and five departments with part of their territory in high forest or forest (Ayacucho, Cajamarca, Huánuco, Junín and Cusco) where only tilapia is grown or in polyculture with gamitana (*Colossoma macropomum*), paiche (*Arapaima gigas*) and pacu (*Piaractus brachyomus*) (Fig. 5). However, officially only the department of San Martín is authorized.

The Peruvian Amazon has many areas suitable for the development of aquaculture. The Peruvian Amazon Research Institute (IIAP 2016) points out that the highway axis of Iquitos - Nauta in Loreto has an estimated 269,787 ha with suitability for fish aquaculture. Similarly, in the department of Madre de Dios, an

area of 832,974 ha is estimated to be available and suitable for fish farming, agricultural and forestry activities, and these activities can be complementary. Considering the type of terrain, accessibility, water quality and temperature, an additional 30,000 ha is available in the departments of Junín, Huánuco, Ucayali, Amazonas, Pasco, Ayacucho, and Cajamarca, where tilapia could be cultivated in different systems (Fig. 6).

FUTURE SCENARIO FOR TILAPIA CULTURE IN PERU

Peru has very good conditions for the growth and expansion of tilapia culture, with special emphasis on Amazonian environments. Likewise, in the world there are available technologies for production intensification and for efficient water use through recirculation systems and complementary aquaponic systems.

The small- and medium-scale producers of San Martín intend to formalize their relationship with the government, improve their production systems, improve seed quality and intensify their crops, representing a short- and medium-term opportunity to increase crops of tilapia. The presence of the National Fisheries Health Organization in production areas work to ensure the health and safety of the crops, being an aspect that provides security to national and international markets.

Considering the current production area and taking into account the growth rate of tilapia crops (7.1 percent), and the growth rate of Peruvian aquaculture (11.6 percent) (Mendoza 2016), we can project to 2025 that tilapia harvests could conservatively reach 6,500 t and potentially 12,000 t. Also, considering that a normative change could expand the cultivation areas of the Amazon and that the adaptation of technologies favor the development of their crops, it is optimistically projected that tilapia production could reach 27,000 t by 2025 (Fig. 7).

The study “Evaluation of the Impact of the Introduction of Exotic Species in the Huallaga River Basin,” elaborated by the IIAP, concludes that the physical and biological factors that hinder the acclimatization and installation of tilapia in the natural environments of this basin is the considerable speed of the current of the water courses and its predominantly stony riverbed, different from the original preferred habitats of tilapia, and the high fish biodiversity favor full occupation of ecological niches (IIAP 1998). The presence of predators and the opportunistic nature, in terms of the feeding of many species, makes it more difficult for a foreign species to enter.

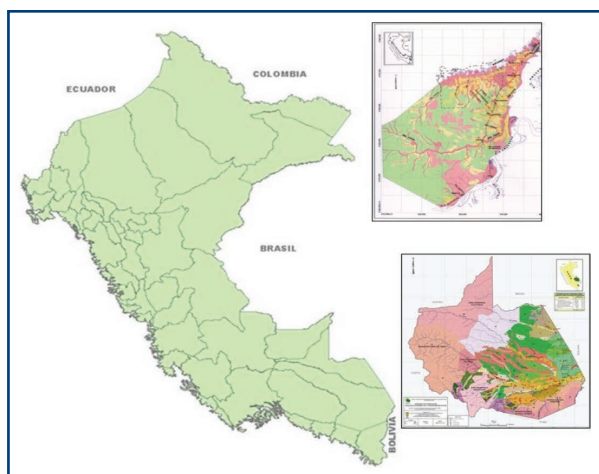


FIGURE 6. Areas suitable for aquaculture in the Peruvian Amazon (Source: IIAP Thematic Maps).

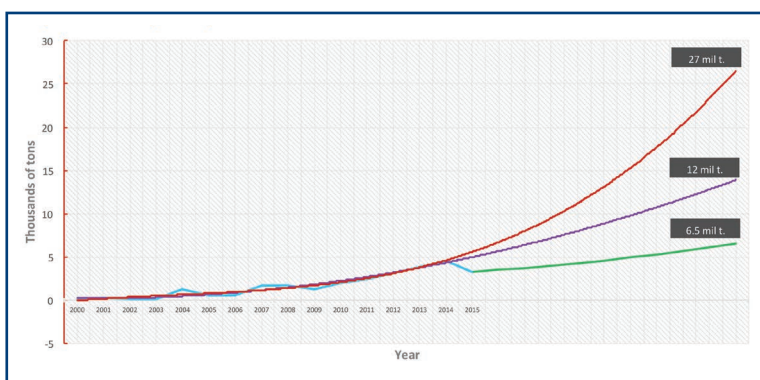


FIGURE 7. Projection of tilapia crops to 2025.

However, in lentic environments where the species was intentionally stocked, it has become naturalized. In lotic environments, swift currents do not allow successful tilapia nesting.

Considering that the rivers in the Amazon are large and that there is a diversity of predatory species that would not allow the expansion of tilapia in natural environments, tilapia crops properly managed in the Amazon could be viable, considering that these should only be done in confined environments

(earthen and concrete tanks, geomembrane or fiberglass tanks, in aquaponic systems or RAS systems), with the use of monosex seed and taking into account measures to prevent escapes. Cage systems in natural lentic environments should not be used where the risk of escape and establishment of the species is greater.

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Notes

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MANY DEPARTMENTS IN THE COUNTRY HAVE THE CONDITIONS TO DEVELOP TILAPIA CULTIVATION, WHICH BY THE EASE OF CULTIVATION AND EASY ACCESS TO LOCAL MARKETS, COULD CONTRIBUTE TO THE LOCAL AND REGIONAL DEVELOPMENT OF EACH AREA, IN ADDITION TO CONTRIBUTING TO FOOD SECURITY AND REDUCING POVERTY.



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