

AQUACULTURE IN COLOMBIA

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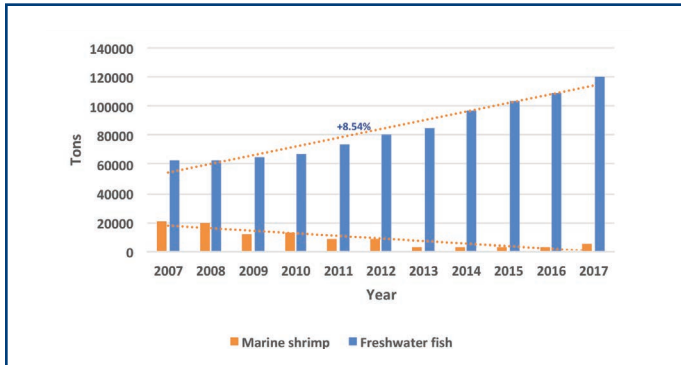


FIGURE 1. Aquaculture production in Colombia, 2007-2017. Source: Ministerio de Agricultura y Desarrollo Rural - MADR - Analysis FEDEACUA 2018.

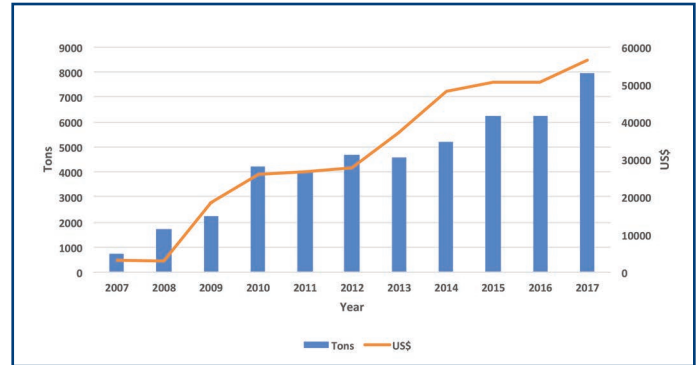


FIGURE 2. Production (t) and value (US\$) of fresh and frozen fillets (tilapia and trout) exported from Colombia, 2007-2017. Source: USDA, PTP, SICEX – Análisis FEDEACUA 2018.

Aquaculture production in Colombia in 2017 grew by 10.2 percent compared to 2016, with 120,230 t produced (AUNAP 2014). In the last decade aquaculture production grew at an average annual rate of 8.5 percent (Fig. 1). However, over the last decade, shrimp production decreased by 11.9 percent due to disease and market factors.

In 2017 fish production by species was: 73,641 t of hybrid red tilapia (*Oreochromis* sp.) and Nile tilapia (*Oreochromis niloticus*) (61 percent of total), 22,455 t of cachamas (*Piaractus brachipomus* and *Colossoma macropomum*) (19 percent of total), 20,226 t of rainbow trout (*Oncorhynchus mykiss*) (17 percent of total) and 3,907 t of other species (native fish such as piracucu *Arapaima gigas*, bocachico *Prochilodus magdalenae* and yamu *Brycon amazonicus*) (3 percent of total).

Huila department (state) is the main national producer with 46 percent of national production, mainly of red and Nile tilapia. In second place is Meta state with 13 percent, followed by the states of Antioquia, Cundinamarca, Boyacá and Tolima, each with 5 percent (FEDEACUA 2018).

In 2017, 7,953 t of fresh and frozen fillets with a value of US\$ 56.5 million were exported from Colombia, representing an increase of 4 percent compared to the previous year (87 percent tilapia and 13 percent trout; Fig. 2). The strengthening of exports of fresh fish to the United States and Canada continues in 2018. Production dynamics continue to specialize in crops destined for foreign markets with the export of fresh fillets (93 percent) and frozen special cuts (7 percent).

Of the national production, 24 percent is destined for the export market and 76 percent is marketed domestically. In Betania, Nile tilapia are produced for the export market and red tilapia are produced for the domestic market. The domestic market has the challenge of increasing domestic consumption as indicated by the Sectorial Business Plan for Fish Farming in Colombia (FEDEACUA 2015). In 2017 the per capita consumption was 7.1 kg/yr and promotional activities are being taken to expand consumption rate to the Latin American average (11.5 kg/yr). By 2032, the target is to

reach the current world average consumption of 19.8 kg/yr (Bonilla 2018).

In Colombia, reservoirs for electricity generation have been used for aquaculture, as in the case of Betania and Prado reservoirs. Huila state is the main producer of tilapia in Colombia and a large proportion of tilapia is produced in large cages in Betania reservoir. This reservoir was built for the generation of electric power and began operation in 1987 with a capacity of 510 MW, later expanded to 540 MW, and has an area of 7,400 ha. Of the total area of the reservoir, about 2,700 ha corresponds to the most viable area (40 percent of the total) and 89 percent of the fish projects are installed in these areas.

Aquaculture started in Betania reservoir during the 1980s with the farming of red tilapia in floating cages. Initially high-volume, low-density cages were used (6 × 6 × 1.5 m), but then high-volume cages of approximately 22-25 m in diameter and 3-4 m in depth were implemented, with useful volumes up to 2,000 m³. Densities vary depending on the volume of the cages and the stage of the crop, ranging from 600 fish/m³ in the nursery phase and from 150-250 fish/m³ in the last period of growth. Production from Betania in 2012 was 23,991 t (Merino *et al.* 2013), representing an increase over the period of 2003-2012 of 5.2 times. The maximum carrying capacity of the reservoir was estimated to be around 33,000 t/yr (Pinzón-Ramírez and Assmus 2003), however at present this level is considered to be too high and uncertain. When carrying capacity is exceeded, problems of water quality in the cages and surrounding areas become frequent, as well as sudden and large fish kills, accentuated in the dry season. Given the importance of Betania reservoir for tilapia production and the losses that have occurred in the past, today producers and government entities are joining efforts to organize the sector without affecting other producers or the supporting ecosystem.

In this context, reducing the impacts of aquaculture and conflicts generated by the use of water and soil with other agricultural activities is a priority. Some producers have opted to



LEFT AND RIGHT: Intensive tilapia farming in cages in Betania reservoir.



LEFT AND RIGHT: Red and Nile tilapia produced in cages in Betania reservoir.

intensify production through biofloc technology to develop a more environmentally friendly aquaculture, particularly in the north of the country. The farms that apply this technology use geomembrane-lined tanks of 100-200 m³ capacity and produce maximum crop densities that range between 20 and 25 kg/m³. In some cases, alternative sources of energy, such as solar and wind, are used to reduce production costs.

New aquaculture initiatives have recently been implemented in regions previously affected by the armed conflict in Colombia. Groups of victims and ex-combatants are developing fish production projects financed with government resources or international cooperation. Fish farming also plays an important role as an activity for the substitution of illicit crops in the country.

STRATEGIES TO INCREASE PRODUCTION AND COMPETITIVENESS IN AQUACULTURE

In 2016, the Sectoral Business Plan for Fish Farming in Colombia (FEDEACUA 2015) was completed with a prospective vision and a strategic plan to the year 2032. Also in 2016, the participation of the national fish farming sector was consolidated in the planning matrix of the National Strategic Interest Plan (PINES) led by the president of the country under the leadership of the Ministry of Commerce, Industry and Tourism, and for 2017 its execution progressed with several lines of action.

An important variable of productivity and competitiveness in the aquaculture sector is the functionality of fish processing plants, with HACCP certification granted by the National Institute for Food

and Drug Surveillance (INVIMA). This certification provides the opportunity to export fish and meets rigorous safety standards that allows presentation of a high-quality product to the national market in accordance with current regulations. There are 13 processing plants certified to export to markets in the United States and Canada and 8 of these are also certified to export to the European market. For Latin American markets (e.g. Peru, Mexico and Chile), a special procedure is carried out before INVIMA. During 2016, primary production was certified at a greater volume than that destined for export under the ecolabelling standards of BAP, ASC and GlobalGAP. The fish farming sector in 2017 had an increase in employment of 6 percent. All jobs that are part of the export chain are formal, with 36,609 direct jobs and 108,207 indirect jobs generated (Bonilla 2018).

TRAINING OF HUMAN RESOURCES AND RESEARCH IN AQUACULTURE

Since its beginning, aquaculture in Colombia has been accompanied by different government entities. Among them, public universities have been dedicated to training and generation of knowledge to accompany and support productive development. The main public universities and their lines of research are:

Universidad de Córdoba was a pioneer in studies with the native bocachico fish and the first higher education institution to offer training specific to aquaculture. In fish reproduction, the university seeks to identify early predictors of spawning quality, produce fingerlings and raise broodstock with biofloc technology;

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LEFT: A fillet of Nile tilapia produced in cages in Betania reservoir destined for export. RIGHT: Intensive trout production system in Antioquia state.



LEFT: Rainbow trout farmed in Colombia. RIGHT: Cachama cultured in Colombia.

also develop and standardize native fish cryopreservation protocols (effects of thawing temperature and packing volume). The effect of heavy metals (cadmium and mercury) on the reproduction of native fish and the reproductive performance of migratory fish in the Sinú River under the operation of the URRRA Hydroelectric company is studied. In the area of nutrition, the effect of plant-derived lipids on the reproductive performance of the Nile tilapia is studied; The production of live feed and protocols for cryopreservation of microalgae (*Scenedesmus* sp., *Ankistrodesmus* sp.) is also carried out.

Universidad de los Llanos is a leader in the development of a technological package for production of white cachama *Piaractus brachypomus*. In addition to making an important contribution in education at the postgraduate level (specialization, M.S. and Ph.D.), the university is currently engaged in study of species of the Orinoco River basin for productive purposes, fish reproduction, cryopreservation of gametes and artificial insemination, feeding and nutrition of aquatic organisms, production of native plankton from the Colombian Orinoquia region, and the study of nutrient dynamics in aquatic ecosystems. The Universidad de los Llanos has made important contributions to the understanding of ornamental fish biology, as well as production systems in fish farming and the physiology and toxicology of aquatic organisms.

Universidad de Nariño contributes to the aquaculture of the country through the training of aquaculture engineers and to the generation of scientific knowledge that contributes to aquaculture

sustainability, particularly in its environment. The university is currently developing studies with alternative raw materials for tilapia such as quinoa, sweet lupin, meal from the processing of white shrimp *Litopenaeus vannamei*, and bovine myocardium in diets for tilapia fry and fingerlings, coffee pulp added to diets for white cachama, and hydrolyzed meal from rainbow trout viscera.

The university also evaluates the quality of national and imported fingerlings of rainbow trout, with emphasis on the presence of parasites and their role as a limiting factor in production. In the environmental area, it studies natural resources such as Guamez Lake and the relationship with trout production, and socially strengthens the association of small- and medium-sized trout farmers through the corporate network as an associative strategy.

Universidad Nacional de Colombia has nine locations in the country, of which at least three include training for aquaculture in undergraduate and postgraduate courses. The characterization of microorganisms present in biofloc systems for red tilapia using autochthonous carbon sources from the state of Cesar is one of the research areas. Additionally, aquaponics is studied as a rural educational model and as a tool for food security. Recent work with indigenous communities has been developed by installing agri-aquaculture systems integrated in polyculture and using periphyton. The adoption of Best Aquaculture Practices and the development of value-added products such as smoked tilapia has been stimulated. The study of systems with efficient water use such as biofloc, RAS



LEFT: Small-scale farmers of the native fish species cachama and bocachico. RIGHT: Silver arowana *Osteoglossum bicirrhosum* male with fry. Ornamental native fish are produced in the southern region of Colombia.



Aquaculture in the Jimain indigenous community, Resguardo Arhuaco. LEFT: Native fish production in an integrated agri-aquaculture system. RIGHT: Workshop on native fish production in integrated agri-aquaculture systems.

and aquaponics are priority research areas.

Universidad del Magdalena is a leader in the cultivation and genetic improvement of oysters *Nodipecten nodosus* and *Argopecten nucleus*, generating interest in its cultivation in private companies and small producers in the area. It has also contributed to the development of technology for production and cultivation of the burgao snail *Cittarium pica*. Studies have been developed related to the culture of estuarine fish, such as *Centropomus undecimalis*, its maintenance and growing in captivity and research related to the effects of environmental factors on fish larval development, essentially light, photoperiod and their effect on spawning induction and the effect of temperature on sex determination in fish using molecular tools (e.g., RT qPCR). The institution is also a national pioneer in knowledge related to the acclimation and production in captivity of sea cucumber *Isostichopus* sp. Its researchers have developed research and extension projects related to the processing of fish and aquaculture products (sausages, canned, antipasti), training fishermen, women heads of household, students of schools, colleges and entities of technical and technological training. Their teachers / researchers have been trainers, both at undergraduate and postgraduate levels, because they have the only fisheries engineering

program in the country. The university offers a biology program and a Master in Aquaculture degree, and has more than 12 years of training personnel specializing in aquaculture. The Doctorate of Marine Sciences is offered in consortium with other five other universities nationwide. In this context, Universidad del Magdalena contributes to the diversification and dynamism of aquaculture in the country.

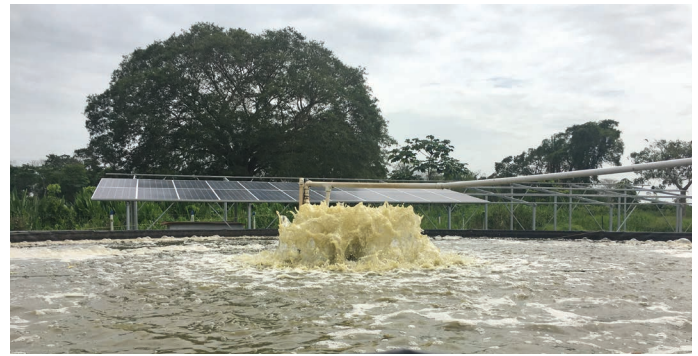
PUBLIC AND PRIVATE ENTITIES RELATED TO THE AQUACULTURE SECTOR

In the country there are several public and private entities that develop activities that seek to promote aquaculture development.

AUNAP (National Authority of Aquaculture and Fisheries) exercises the fisheries and aquaculture authority of Colombia, through planning, research, regulation, promotion, registration, information, inspection, monitoring and control of fishing and aquaculture activities, applying the sanctions that may arise, within a policy of promotion and sustainable development of fishery resources.

FEDEACUA (Colombian Federation of Aquaculture Producers) is a non-profit organization founded in 1998, which positioned itself as a national association in 2012, achieving the goal of fish farming

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LEFT: Small-scale fish farmer in Caparrapi. RIGHT: Red tilapia production in biofloc technology (BFT) using a solar energy system, Arauca state.

as a world-class sector within the framework of the productive transformation program (Bancoldex - Ministry of Commerce, Industry and Tourism). In 2014, FEDEACUA obtained tacit participation as representative of the sectorial board, as well as continuing with the scheme of belonging to the National Council - Aquaculture Chain of the Ministry of Agriculture and Rural Development as a principal member.

CENIACUA (Aquaculture Research Center) is the entity that manages public and private resources to improve the productivity and sustainable development of Colombian aquaculture to increase its supply in national and international markets. For this, CENIACUA generates the scientific and technological knowledge applicable to aquaculture, with the help of the human, physical and economic resources of the nation, and to strengthen the participation of entrepreneurs in the sector.

INVIMA (National Institute for Surveillance of Drugs and Foods) is a scientific and technical monitoring and control entity that works for the protection of individual and collective health of Colombians through the application of sanitary norms associated with the consumption and use of food, medicines, medical devices and other products subject to health surveillance.

ICA (Colombian Agricultural Institute) is the entity responsible for agricultural health and agro-food safety. Its purpose is to contribute to the sustained development of the agricultural, fishing and aquaculture sector through prevention, surveillance and control of health, biological and chemical risks for animal and plant species, applied research and administration, research and management of resources fishing and aquaculture to protect the health of people, animals and plants and ensure the conditions of trade.

Although there is no ministerial level entity for aquaculture in Colombia, there are three entities that have specific authorities related to the sector: the Ministry of Agriculture and Rural Development; the Ministry of Commerce, Industry and Tourism; and the Ministry of Environment and Sustainable Development.

PROJECTIONS FOR AQUACULTURE IN COLOMBIA

It is expected that aquaculture will continue to grow at a high rate, above the growth of other livestock activities such as chickens, pigs and cattle. Furthermore, its intensification (industrialization) will consolidate farms with biofloc and aquaculture recirculation technologies that allow a socially acceptable aquaculture development that is economically profitable and friendly to the environment. It is also foreseen that aquaculture will be an important activity in the post-conflict period in terms of food security and employment generation.

Universities, government entities and producers will have to work together to search for solutions to technical, scientific and governance problems for the development of the activity in the coming years that will allow Colombia to position itself as a leader in the region.

Notes

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