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Situation diagnosis of the arapaima fish-farming (*Arapaima gigas)* in the Peruvian Amazon

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ABSTRACT: The arapaima (*Arapaima gigas*) is one of the main commercially important fish of the Peruvian Amazon and is included in CITES Appendix II[1]; since in past decades it suffered from overfishing that endangered natural populations, until it almost disappeared from the Amazonian markets. Now, with the aquaculture activity, the arapaima can be sold in the national and international market, as this activity has been an important tool for the conservation of this species. The diagnosis carried out is a compilation of office information and technical visits to the farming centers in the departments of Loreto, Ucayali, Madre de Dios, San Martin, Huanuco and Junin, where an analysis was made of the rights granted under the new General Aquaculture Law, as well as their form of farming, the form of feeding in the farming ponds and the evolution of the CITES Certificates. In addition, a working outline of the production chain of this resource in Peru has been prepared, in addition to providing recommendations for improving the arapaima farming.

KEYWORDS: Arapaima; CITE (Centro de Innovación Tecnológica), CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), Appendix II, Fingerlings, Production Chain, By-products, Hatchling Raising, DIREPRO.

The arapaima in Peru

[1] Appendix II lists species that are not necessarily threatened with extinction but could become so unless trade is strictly controlled. This Appendix also includes so-called "look-alike species", i.e., species whose specimens in trade are similar to those of the species listed for conservation reasons. - https://cites.org/esp/app/index.php

Currently in Peru, the departments of Ucayali and Loreto have the largest number of aquaculture rights granted for arapaima farming; the Department of Ucayali has a total of 694 rights[2] (313.44 hectares), Loreto has 251 rights (518.69 hectares), followed by San Martín with 166 rights (244.49 hectares), Madre de Dios, with 23 rights (97.82 hectares), Piura (14 rights with 2.35 hectares), Huánuco (11 rights with 9.22 hectares), Junín (10 rights with 12.36 hectares) of water surface; these are the main departments at the national level, as shown in the following chart:

Aquaculture Rights that have been farming arapaima at National Level by Departments

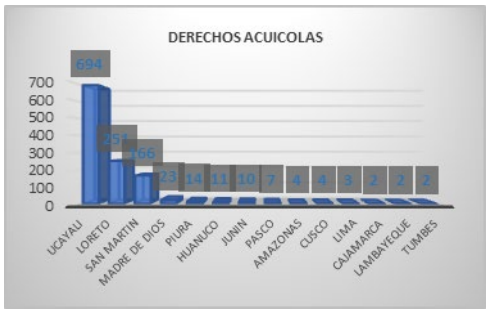

Chart 1: Aquaculture rights for the farming of arapaima and other species.

Source: Aquaculture Records. Prepared by the Company.

In terms of production level, (AREL, AMYPE y AMYGE[3]), the largest number of aquaculture rights have been granted to individuals under the AREL scheme with 666 aquaculture rights in 143.98 hectares of water surface, followed by AMYPE with 525 aquaculture rights in 1084 hectares of water surface and AMYGE with two rights and 18.16 hectares of water surface, which in the case of arapaima is not yet fully developed.

The following chart shows the issuance of aquaculture rights in recent years.

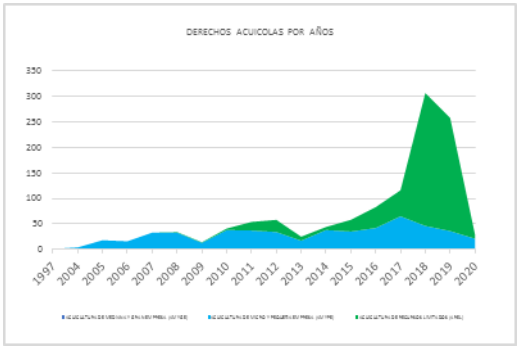

Chart 2: Aquaculture rights granted per year for the cultivation of arapaima and other species by level of production.

Source: Aquaculture Records. Prepared by the Company.

The boom in the number of rights granted in recent years could be the result of the formalization and promotion campaigns carried out by the Peruvian Ministry of Production (PRODUCE) and the Regional Governments (GORE) at the national level, in addition to the relaxation of the requirements for Aquaculture of Limited Resources (AREL), which led many people to obtain their aquaculture rights

[2] Information compiled as of October 31, 2020.

[3] DS. 002-2020 that modifies the Regulations of the General Aquaculture Law.
Productive Scales:
10.1. Limited Resource Aquaculture (AREL): It is the activity developed exclusively or in a complementary manner by individuals, who must meet all the requirements established for this category, covers the basic family food needs and is mainly carried out for self-consumption and self-employment oriented enterprises. This category includes aquaculture activities carried out by non-commercial basic education centers. AREL's annual production does not exceed 3.5 gross tons.
10.2. Micro and Small Enterprise Aquaculture (AMYPE): It is the activity carried out for commercial purposes by individuals or companies. AMYPE's annual production is greater than 3.5 gross tons and does not exceed 150 gross tons.
10.3. Aquaculture of Medium and Large Enterprises (AMYGE): It is the activity carried out for commercial purposes by individuals or companies. AMYGE's annual production is greater than 150 gross tons."

in recent years but who have not necessarily been carrying out activities.

VERIFICATION AND CHARACTERIZATION OF THE MOST REPRESENTATIVE ARAPAIMA FARMING CENTERS IN THE PERUVIAN AMAZON

Fingerlings Production and Management

In Peru, Ministerial Resolution No. 071-2019-PRODUCE, which approves the guidelines for monitoring arapaima from aquaculture, is in force and governs the actions to be followed in the reproduction, raising and farming of the arapaima in Peru. In summary, the objective of the regulation is that after a reproductive event, the fish farmer notifies the Regional Production Boards (DIREPRO), which carry out an on-site inspection of the fish farm, the release (collection of the arapaima fingerlings) is carried out and a record of the birth is filled out; documentation that is later used to obtain the CITES Certificates.

Feeding varies at this stage. Initially, sometimes they are given balanced feed together with filtered live food found in the very farming ponds.

Until a few years ago, mortality in the raising process ranged between 50 and 60%, but with the use of balanced feed in the first stage and filtering live feed from the ponds, mortality has been reduced to 15 to 20%, according to fish farmers.

Normally, reproductive events occur according to the age of the arapaima. According to fish farmers, a 4-year-old fish can produce one reproductive event per year, while a fish between 6 and 8 years old can produce up to seven reproductive events per year. The average number of specimens obtained in the average breeding season is between 2,000 and 3,000 specimens.

Juvenile Production and Management - Fattening

There is currently no single methodology for cultivation, since producers maintain this hydrobiological resource according to their needs and experience. The major infrastructure found has been earthen ponds. For the juvenile and fattening stage, no differences have been observed in the construction of ponds that are also used for broodstock or the cultivation of other Amazonian species.

Once the fish are raised and brought to sizes greater than 10 cm, they are placed back into the earthen ponds. According to fish farmers, the use of feed at this stage is a major increase in production costs and considerably reduces their income.

At this stage, the vast majority of fish farmers do not carry out any selection in the ponds and keep the fish until they reach 15 to 18 kilograms (ages between 14 and 18 months), when they are marketed.

Some fish farmers are already starting to market them from 12 kg onwards. Marketing prices are between 12 and 15 soles per kilogram placed on the farm.

The average stocking density for obtaining commercial specimens is five animals per m^2; however, the ponds are underutilized because the fish farmers do not have a real knowledge of the demand for arapaima. As for the

estimated Feed Conversion Factor, it is around 5:1.

Broodstock Production and Management

There is no differentiated methodology for the management of broodstock in ponds, since producers maintain this hydrobiological resource according to their needs and experience. The largest infrastructure found has been those known as earthen ponds, for the reproduction and fattening stage. The dimensions vary according to the topography of the land, with ponds ranging from 300 m^2 to more than 2,000 m^2 on average.

Most of the ponds have been built in clay soils due to their impermeability and are mostly filled and fed only with rainwater. Pond heights also vary, ranging from 0.80 to 1.5 meters in height.

In most of the farms visited, an empirical learning process typical of the field has been observed in this activity. In some cases, fish farmers with broodstock indicate that the reproductive event occurs when there is a change in climatic conditions (onset of rains or some anomalous event), which causes the broodstock to become stimulated and reproduce. This behavior should be investigated by the authorities or institutions in order to verify or not what the owners of these farms indicate.

Reproductive events generally occur at the end of October, beginning of November or when the rains begin, and the courtship stage and subsequent care of the nest is carried out by the male. According to the fish farmers who carry out the reproductive event, from the fourth day on, the arapaima hatchlings can already be distinguished as they come out to breathe.

Spawning takes place at dawn and often due to the force of the courtship between the animals there have been deaths, especially of the females.

Once the arapaima farmer has seen that the reproductive event has taken place, he carries out what is known as the raising, which consists of separating the parents from the young and taking them to other ponds or selling them.

CITES CERTIFICATES IN PERU

From 2004 to 2020, 1,612 CITES Certificates have been issued for products from the wild and arapaima from aquaculture. The number of CITES Certificates for species from aquaculture (arapaima) was 1,234 CITES Certificates. Exports have basically been for arapaima fingerlings (79.4%), meat (18.56%), skins (0.89%), leather (0.81%) and others (0.32%), according to the following table:

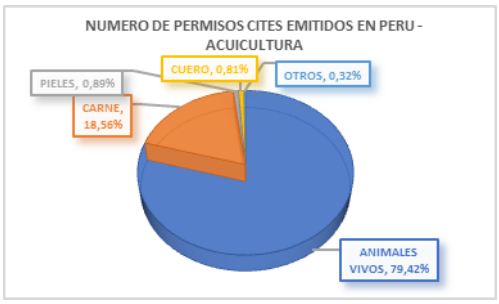

Chart 3: CITES certificates issued by type for export of arapaima from aquaculture (2004 - 2020)

Source: Ministry of Production - VUCE

Exports of Live Arapaima (arapaima fingerlings)

The external commercialization of arapaima specimens (fingerlings, juveniles and adults) is mostly for ornamental purposes and is of high growth, from the 1,156 fingerlings requested for export in 2011, it increased to 88,830 in 2015, when the highest export of this species was recorded. During 2020, Export Certificates were granted for 20,021 specimens; lower than the amount requested in 2019 (64% lower), when CITES Certificates were issued for the export of 55,811 arapaima fingerlings. This decrease was mainly due to the closure of international markets due to the COVID 19 pandemic.

Chart 4: Export of Live arapaima from Aquaculture

Source: Ministry of Production Prepared by the Company.

The 20,021 specimens requested for export in 2020 have had Hong Kong as the main destination country with 13,647 units representing 63.1% of the total exported, followed by the United States with 14.3%, Vietnam with 5.5%, South Korea with 4.2%, Japan with 3.5%, Indonesia with 3.4%, the Netherlands with 2.8%, Thailand with 2.3%, Canada and the Philippines with 0.5% each.

Chart 5: Countries that exported arapaima fingerlings in 2020

Source: Ministry of Production Prepared by the Company.

Arapaima Meat Exports

The export of arapaima meat has not been constant, with no sustained growth between 2004 and 2020. There are references that the first export of arapaima meat was in 2004, when only 5 kilograms were exported. Commercial exports began in 2010 with 2,026 kg. The peak of arapaima meat exports occurred in 2013 with just over 111 tons, declining to 101.10 kg in 2019 and only 15 kg in 2020; it should be noted that the decline in arapaima exports has been due to the economic difficulties of the companies involved in this activity; many of them are analyzing reducing or closing their activities for the farming of this species.

Chart 6: Export of arapaima fingerlings per year

Source: Ministry of Production Prepared by the Company.

DETAILED DESCRIPTION OF THE STRUCTURE OF THE PRODUCTION CHAIN OF ARAPAIMA FROM AQUACULTURE BY TYPE OF PRESENTATION (FINGERLINGS AND JUVENILES FOR ORNAMENTAL PURPOSES, MEAT AND SKIN).

According to documentation found in PRODUCE[4], the production chains are defined as a set of economic agents directly involved in the production, processing and transport of agricultural products to the market (Durufle, Favre and Young, translated by IICA).

The aquaculture production chain in Peru, especially for arapaima, involves several components that are important for the development of the aquaculture activity of this species.

In terms of obtaining seed, the arapaima farming began with the use of natural seed from the various Amazonian lakes. At present, the seed comes from the reproduction carried out in the very ponds.

Regarding the farming component, it is pointed out the way of growing the ponds, the farming, and the type of feeding until the harvest where specimens of 10 to 14 kilograms are obtained from the year of farming.

The processing component of the arapaima production chain refers to primary and industrial processing. Primary processing includes cleaning, gutting, beheading, slicing and filleting, while industrial processing includes chilling, freezing, packaging and curing, among others.

In recent years, there are entrepreneurial companies that have been using arapaima by-products for the manufacture and tanning of leather for the production of wallets, handbags, among others, as part of the insertion of the circular economy in aquaculture.

As for the market component, the arapaima is currently exported under the conditions established by CITES and must have a certificate issued by the Ministry of Production, through the General Board of Aquaculture when this species is farmed; the production chain also includes wholesale, retail and the final consumer.

In summary, the arapaima production chain is detailed in the following table:

4 http://www2.produce.gob.pe/RepositorioAPS/3/jer/ACUISUBMENU4/boletines/CADENAS%20PRODUCTIVAS.pdf

CADENA PRODUCTIVA DEL CULTIVO DE PAICHE EN EL PERU

RECOMMENDATIONS FOR THE IMPROVEMENT OF ARAPAIMA FARMING IN PERU

After the analysis of arapaima cultivation in Peru, some recommendations have been made, such as:

Market Aspects

1. Generation of Business Rounds/ Productive Meetings for market access with this species.
2. Conceptualize the characterization of the value chains of the arapaima marketed in the main regions of Peru.
3. Preparation of market studies for the arapaima in the main regions of Peru.

Production Aspects

1. Greater impetus to aquaculture extension, that includes as a priority the farming and the improvement of the production chain through the Development of Technical Assistance Modules for arapaima farming to be carried out by aquaculture extensionists.
2. Inclusion of Business Plans/Projects as a mandatory requirement in the products of aquaculture extensionists who have been supporting arapaima farming, as a form of financial leverage.
3. Promotion of technologies that use higher planting densities in the same farming space.
4. Proposal for determining the sex of arapaima from molecular sexing, by the sexual

dimorphism of the arapaima, which does not allow them to be selected in a short time.

5. Proposal to stimulate arapaima farming based on environmental changes to optimize reproduction.

Regulatory and Governmental Aspects

1.Conduct a suitability analysis for the modification of the Tilapia Management Plan in San Martin and Junin and its implications for arapaima farming.

2. Negotiations for the modification and inclusion of tariff items for endangered species in CITES trade, for greater traceability and control by government agencies.

3. Systematization of the procedures of the Regional Production Boards that are requirements for obtaining the Certificate CITES issued by the General Board of Aquaculture, to guarantee the traceability of the arapaima in Peru.

4. Analysis of the convenience of issuing AREL permits for arapaima due to its farming method, which would lead to the Modification of the Regulations of the General Aquaculture Law.

5. Generation of Aquaculture Generated Fisheries (Repopulation activities as a government policy in Amazonian water bodies where arapaima became a means of subsistence for native communities near these water resources, accompanied by PROMAPE (Fisheries Management Programs).

Circular Economy Aspects

1. Coordination with the CITE leather and footwear of the Instituto Tecnológico de la Producción for training and technical assistance to produce by-products (arapaima leather) for aquaculture extensionists and fish farmers.

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