



Aquaculture enterprises in Chile and Mexico, productive articulation approach and internationalization

Juan José Huerta Mata^{1*}, Lionel Valenzuela Oyadener²

¹ Professor, Department of Administration, University of Guadalajara, University Center of Economics and Administrative Sciences, Jalisco, México

² Engineering sciences, Director of Business School, Technical University Federico Santa María, Valparaíso, Chile

Abstract

Aquaculture, in the level world, has taken important relevance as an alimentary strategy for ensuring the harvest of natural products for human consumption in the following decades. According to FAO (2018), 50% of fish and marine products will have to be produced in controlled environments in a pond and artificial water bodies by 2030, reason why the major exporting countries of this type of products will have to be more efficient and effective in their production volumes.

Chile and México share their vision of developing to the enterprises that belong to this sector, so your purpose will be in the next ten years consolidate its aquaculture production centers under natural conditions, the leading cultivated species are salmon, and trout; tilapia, shrimp, and bullfrog, respectively in each country.

The main objective in this document is to analyze the regulation, operating conditions, and degree of productive articulation in networks or clusters of aquaculture enterprises; the main Research findings and solution alternatives to promote the internationalization of organizations in this sector are presented.

Keywords: aquaculture farming sea products food production Mexico Chile

Introduction

The alimentary challenge that humans have to face in the following decades will force countries to develop more efficient alternatives for the natural food harvest. Agriculture brings the opportunity to impulse eco-friendly and sustainable systems without affecting the loss of fish, mollusks, and amphibian species threaten in nature.

World stage, important territorial extension countries in the coast area and water bodies inside provide a great number of natural resources used for the fishing and cropping of marine resources. Nonetheless, the overuse of fishing resources among the past years, without respecting closure or the recovery of fishing boats, has drawn the attention to developing the species production depart from farms and cropping centers to foster sustainable development, and in some cases like Chile, exporting products to different countries around the world.

Therefore, the current situation analysis of aquaculture companies in Chile and Mexico has special relevance to improving the competitiveness and commercialization of their products in terms of sanity, innocuousness, and dietary quality regulations as well as intern processes operation conditions.

On the other hand, the productive articulation has been developed in the past years as a new association strategy among companies, public organizations, and educational institutions, generating positive collaboration energy, in specific innovation terms, technology and international business, which facilitates the individual and collective achievement, enabling the social-economic grow significantly in the geographical areas where they currently are. This article addresses the aspects previously mentioned, as of field research carried in the Región Lagos in

Chile (Puerto Montt) and the Región Centro Occidente in Mexico (Colima, Jalisco, Michoacan, and Nayarit) during the first and second semester in 2018, results will be presented next.

The inquest to approach in this article itemizes into four sections: theoretical framework of the productive articulation and the current status in both countries, research methodology, research results, and description chain as aquaculture sector business net.

Methodology used for research

The main objective of this document is to analyze the regulation, operating conditions, and the level of productive articulation of nets or clusters in the aquaculture companies and their orientation to the internationalization and commercialization of aquaculture products.

The research work has been made based on ethnography in places where farms and aquaculture companies are. In Chile, the organizations are located in estuaries and water bodies near the Pacific Ocean, particularly in the Lagos region, and their offices are in Puerto Montt city. In Mexico, in the Centro Occidente de Mexico region, water bodies in the interior of the national territory are in the entities previously mentioned.

This study was exploratory, not experimental, using a qualitative approach based on in-depth interviews. Using a 25-question questionnaire distributed as follow; 7 from general data, 13 closed questions, and 5 opened questions; answered by the principal actors of the value chain, key informants, owners or aquaculture companies' representatives, organization producers' coordinators, support agencies for public services and servants responsible of aquaculture, federal or local.

Two articles developed from the research project in both countries: the first one described the general conditions of the agricultural sector in each country. (Huerta, Valenzuela y Esparza, 2020) ^[16]; the second one analyzed the operation characteristics of the wider sector, and the way cropping processes conduct, harvest, and merchandising companies, the level of productive articulation, and its orientation to product placement, in both countries, at the national and international level.

The data analysis has been made based on a comparative study of aquaculture companies in each country, besides the relationship among the sector members, triple helix, (Etskowitz, 2005), and their intervention level to determine the product development level to their commercialization.

It is necessary to point out that the productive articulation of the aquaculture sector has been a line of research worked since 2007, inquest enshrined in a doctoral thesis, (Huerta, 2013) ^[15].

Aquaculture background in Mexico and Chile

Aquiculture in Mexico is an activity of the primary sector that emerges since ancient times. Suffice to mention that, since the foundation of Tenochtitlan in the XVI century, the year 1325 (Johansson, 2015), the principal primary activities of economic development have been documented. Among these activities are fishing and cage fish farming, based on the feeding and the trade among indigenous towns particularly involving barter impulse by the Aztec culture.

Nowadays, some areas in the country keep practicing the ancient craft with their ancestors, such as the South Mexico area, in entities like Veracruz, Tabasco, and Chiapas. But also, in the Centro Occidental area in Mexico in places like Colima, Jalisco, Michoacan, and Nayarit. They use modern procedures of farm fishing, shellfish, and mollusks through artificial tanks made out of geomembrane like anoxygenize greenhouse and water recirculation, (Comisión Nacional de Pesca, 2019) ^[32].

Aquacultural developing companies in Mexico presents different levels, from large size farms, focused on harvest, cropping, and commercialization of shrimp, Sonora, Nayarit, and Colima. Bullfrog farms in Michoacan and Jalisco, even small farms for basic family support self-consumption, tilapia, and trout, in Michoacan and Nayarit.

The federal government through the rural development secretary regulates this activity, the Fishing and Aquaculture commission is the one in charge of looking after the operations in the fishing and aquaculture units in the national territory, there are 32 fishing sub delegations, one for each federal entity, and 90 fishing commission offices distributed in the main fishing spots and aquaculture production centers. National wide, the states of Baja California Sur, Campeche, Chiapas, Michoacan, Nayarit, Oaxaca, Sinaloa, and Tabasco, have a larger number of offices.

In the case of Chile, the aquaculture activity started at the beginning of the XX century, when the first trout eggs, cultivated in a small farm from the Federal Government of the country, were sent to Santiago de Chile from Buenos Aires, Argentina to Valparaiso, Chile.

From that time until now the aquacultural activity has grown sustainably, as an answer to the diminishing of wild species to capture through fishing and impulsion the creation of production centers around the country. Because of weather and water conditions, species like Salmon, trout, and Mollusks are mainly harvested.

Nowadays, Salmon production is in three regions with 1350 aquacultural centers: Lagos, Aysén, and Magallanes, with an exportation volume of 1,179,721 tons, with a value of 5.4 thousand million dollars (Sernapesca, 2018).

The central government structure that supports the aquaculture and fishing activity is integrated by the Economy and Tourism Ministry, which has a Subsecretary of Fishing and Aquaculture, the Promoting Fishing Institute, and the National Fishing Service and Aquaculture with a regional sub direction and 48 offices around the country.

Chiles is one of the main farm salmon producers, and takes part in the Four-Nation group, along with Norway, Canada, and Scotland, (Sernapesca, 2018). The interrelationship that exists in this international group is permanent, principally with the purpose of mixed certification of aquacultural products, this means that the cropping centers in Chile are visited and supervised by a specialist from other countries and vice versa. Additionally, the session regularly each year to improve the farming process of this product and detect pathologies that each species may present.

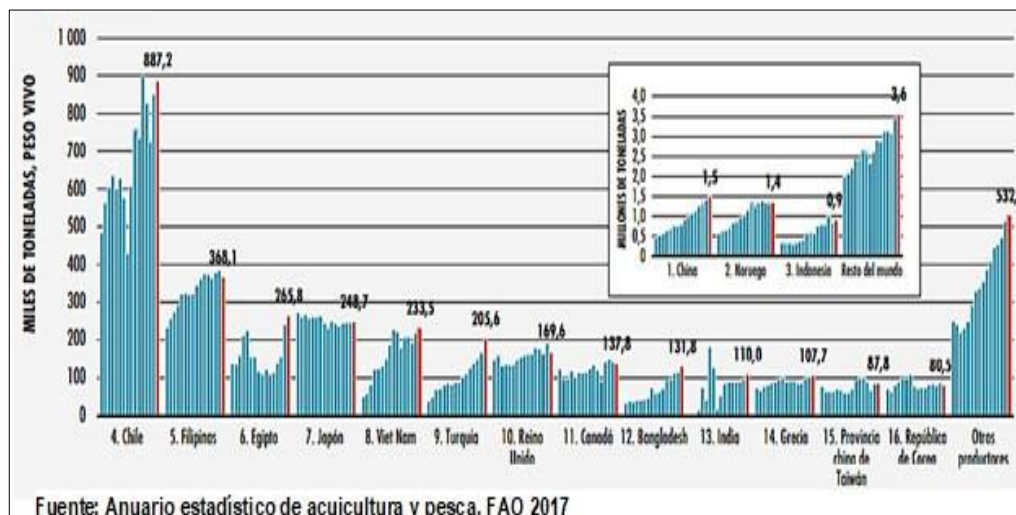


Fig 1: Produccion Mundial de Peces de Aleta de La Acuicultura Marina Y Costera Por Productores Importantes

Cropping centers and aquacultural Chilean companies unlike Mexico presents a major developing degree since the products are mostly put into the international market, mainly in Asia and

Europe because of that, they are national and international regulated which forces them to keep constantly improving, see table no. 1

Table 1: Principales productores acuicolas a nivel mundial

PAÍS	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
TOTAL	70,203	73,835	77,982	81,612	88,172	94,980	99,608	103,876	103,876	103,876
CHINA	44,073	46,063	47,790	49,148	52,083	55,029	57,321	59,369	59,369	59,369
INDONESIA	3,855	4,713	6,278	7,937	9,600	13,301	14,375	15,649	15,649	15,649
INDIA	3,856	3,799	3,790	3,678	4,214	4,555	4,893	5,263	5,263	5,263
VIETNAM	2,477	2,571	2,701	2,861	3,105	3,221	3,355	3,475	3,475	3,475
RE. DE COREA	1,395	1,332	1,377	1,499	1,509	1,533	1,567	1,676	1,676	1,676
BANGLADESH	1,006	1,064	1,309	1,524	1,726	1,860	1,957	2,060	2,060	2,060
FILIPINAS	2,408	2,477	2,546	2,608	2,542	2,373	2,338	2,348	2,348	2,348
EGIPTO	284	285	271	263	254	246	325	360	360	360
NORUEGA	848	962	1,020	1,144	1,321	1,248	1,332	1,381	1,381	1,381
CHILE	871	881	713	970	1,076	1,046	1,227	1,058	1,058	1,058
MYANMAR	675	779	853	819	888	931	964	1,000	1,000	1,000
JAPÓN	1,187	1,243	1,151	908	1,074	1,028	1,022	1,106	1,106	1,106
TAILANDIA	1,331	1,417	1,286	1,201	1,272	998	898	920	920	920
COREA (REP. DEMOCRÁTICA)	509	509	510	510	511	512	557	557	557	557
BRASIL	332	365	412	436	481	478	564	575	575	575
ECUADOR	173	219	273	310	323	332	368	427	427	427
ESTADOS UNIDOS	501	481	497	397	420	429	421	426	426	426
MALASIA	355	473	581	527	635	531	521	507	507	507
IRÁN	155	180	220	247	297	325	320	346	346	346
ESPAÑA	250	267	252	272	264	224	282	290	290	290
NIGERIA	143	153	201	221	254	279	313	317	317	317
TAIWÁN	331	291	315	319	348	349	341	314	314	314
TURQUÍA	153	160	168	189	213	234	234	239	239	239
MÉXICO/a	284	285	271	263	254	246	325	360	389	405
REINO UNIDO	176	197	201	199	206	203	215	212	212	212
CAMBOYA	40	50	60	72	74	90	120	145	145	145
CANADÁ	156	156	162	170	185	168	140	187	187	187
RUSIA	116	117	121	130	146	156	164	154	154	154
FRANCIA	238	234	203	194	206	201	181	164	164	164
PAKISTÁN	135	138	140	142	143	148	148	151	151	151
RESTO DEL MUNDO	1,894	1,975	2,310	2,456	2,550	2,707	2,818	2,840	2,811	2,795

•Fuente: Anuario estadístico de acuicultura y pesca, FAO 2017

Theoretical framework of aquacultural companies in Mexico and Chile, productive articulation.

Pymes in Mexico and Chile, rural area

The reality of small and medium companies in Latin America is very similar in the Hispanic-speaking countries in Mexico, Central, and South America. According to the economic census from INEGI, Mexico (2019), there are 6,373,169 economic units (companies) in the whole country, of which 99.08% are MiPyMes. From this reference, 5,120,250 (82%) establishments

are in urban areas, and 924,571 (18%) in rural areas. 24,372 (2.63%) are economic units from the fishing and aquaculture sector, and 9,563 (1%) to aquaculture installations distributed in the national territory. The main aquacultural producers by production volume and species are concentrated in the Pacific Ocean. The federal entities are Sinaloa, Sonora, Jalisco, Chiapas, Nayarit, Michoacan, Baja California. The main products are Shrimp, bream (tilapia and others), and goldfish, among others, see table no. 2

Table 2: Volumen De La produccion pesquera De acuicultura en peso vivo, por principales especies, segun litoral Y entidad federativa, 2018. (Toneladas)

LITORAL/ENTIDAD	TOTAL	ATÚN BAGRE	CAMARÓN	CARPA	CHARAL	LANGOSTINO	LOBINA	MOJARRA	OSTIÓN	TRUCHA	OTRAS a/	
TOTAL	395,537	10,763	3,449	158,115	27,238	4,687	37	999	135,571	42,107	10,440	2,132
LITORAL DEL PACÍFICO	292,009	10,763	2,106	155,281	13,471	3,716	26	853	97,109	6,305	536	1,843
BAJA CALIFORNIA	13,817	10,763	-	193	-	-	-	586	-	2,097	-	179
BAJA CALIFORNIA SUR	5,782	0	-	3,229	-	-	-	-	3	2,278	-	272
CHIAPAS	27,879	-	-	8	17	-	-	-	27,853	-	-	1
COLIMA	4,990	-	1	4,276	-	-	-	-	709	-	-	3
GUERRERO	4,118	-	21	264	-	-	1	-	3,809	-	3	20
JALISCO	39,229	-	708	62	6,627	2,315	26	16	29,355	-	12	108
MICHOACÁN	19,382	-	972	-	6,035	1,401	-	-	10,408	-	490	76
NAYARIT	20,799	-	-	9,800	-	-	-	-	9,998	1,001	-	-
OAXACA	710	-	-	12	-	-	-	-	667	-	32	0
SINALOA	93,180	-	357	78,613	677	-	-	248	12,494	430	-	361
SONORA	62,122	-	47	58,823	115	-	-	2	1,812	500	-	823

Fuente: Comisión Nacional de Pesca y Acuicultura, México 2019

Aquacultural cropping farms that exist in Mexico are generally for self-consumption or local commercialization. In entities like Chiapas, Nayarit, Michoacan their cropping and harvest methods are rudimentary, they have natural swamps and very simple oxygenation systems. (Huerta, 2013) [15].

The organization in charge of regulating fishing and aquicultural activities in Mexico is the Secretaria de Agricultura, Ganadería,

Desarrollo Rural, Pesca y Alimentación (SAGARPA) through the Subsecretaría de Pesca y Acuicultura, now Secretaría de Desarrollo Rural (SADER), from the federal government as the head of sector. This last one coordinates the Fishing and Aquaculture Commission or Fishing Commissions, Aquacultural sanity committee in each federal entity, government aquiculture centers, and farms existing in the country, see figure no. 2



Fig 2: E estructura de Gobierno apoyo Sector Acuicola

In Chile, there are 572,306 registered companies, among them there are the production aquacultural centers with 2,297 (0.40%) of fish, mollusks, and seaweed, being 1,779 only fish; salmon and trout are the main species.

They are located in littoral waters, and some of them are in freshwater bodies. In the case of salmon, it manages a mixed

process of sweet water in the first growing stages and salty water before being processed or commercialized.

The activity regulation in Chile is in charge of the Ministerio de Economía, Fomento y Turismo, includes the Subsecretaría de Pesca y Acuicultura, Instituto de Fomento Pesquero y el Servicio Nacional de Pesca y Acuicultura, this last one is the one in charge

of supervising and overseeing the aquacultural and fishing activity in the whole country, it has 16 regional offices that attend

directly the fishing and aquicultural companies' organizations, see figure no. 3

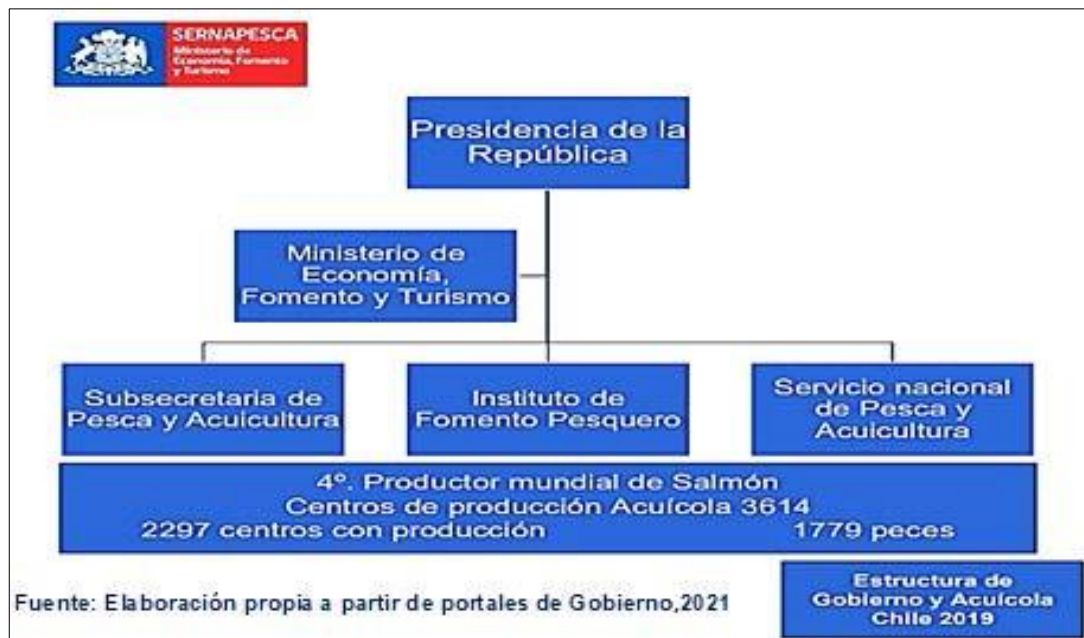


Fig 3: E estructura de Gobierno apoyo A Sector Acuicola

Main areas of aquacultural production through the Chilean territory are region IX Toquimbo, X Lagos, XI Aysén, XII Punta Arenas.

Productive articulation in the aquacultural pymes

Productive articulation comprises diverse modalities which have been used in the five continents, the most common ones are clusters, companies' webs, local productive arrangements or industrial districts, regarding the grouping and region complexity applied is in some cases the name they acquire, among the authors that have studied these concepts is Porter (1998), López (199) Dini *et al.* (1996) ^[10].

The productive grouping analysis highlights the importance of the interaction of different types of companies, principally in the small and big ones. Besides, pointing the cooperation mechanism among companies, the autonomy that each maintains legal and managerial, its voluntary participation, and getting individual benefits through conjunction action, (López, 1996).

In the case of productive grouping attach to aquaculture are Chile (2004), Norway (Phyne *et al.*, 2006), Thailand (Belton and Little, 2008), China (Pemsl and Bose, 2008), Chile and Scotland (Felsenstein, 2008).

The productive articulation degree that aquacultural farms present, according to the cluster focus, (Porter, 2004) and the companies' webs (López, 1999), it still is emerging, linked to the associativity in this type of organization the concept "la triple hélice" (Etskowitz, 2005), which explains the relationship between companies, government, and university, for the growth and group development in the companies' webs or clusters. However, even aquacultural companies coordinate with other actors, the exchange among them is basic, and is only represented by collaborated efforts for very specific projects they obtain as a result for their members, we have to remember that the cluster initiatives have been developed in the world by developing and

transition economies (Ketels, Lindqvist y Solvell, 2003), having marketing and technological intelligence, international sales, regional brands and product development, infrastructure, regulation politics, goods chain integration and value chain, and research and development group as objectives, among others.

On the other hand, small and medium aquacultural companies take a relevant role in Chilean economic development, this activity represents the participation of 4000 small and medium companies, which represent 2267 aquacultural production centers; 61,000 employs, 20,000 direct and 41,000 indirect, contributing an important percentage to the intern raw product of the country, with a production of 953,300 tons., and exportations superior to 5,176 million dollars, (Salmon Chile, 2020).

In Mexico, PyMes plays an important role, from the total companies 6,373,169 establishments around the country (INEGI, 2019), 98.02% belongs to micro and small and medium, from this amount approximately 14.5% is in rural areas where the aquacultural companies and farms belong, located mainly in coastal areas, riverbanks, and mangroves.

Research findings in the aquacultural companies in Mexico, Centro Occidente region, and chile, puerto montt region.

In the fieldwork of this research, I include visits to aquacultural farms in Mexico, in the Federal Entities of Colima, Jalisco, Michoacan, and Nayarit, during April and May 2018. Likewise, I interviewed the federal and state aquacultural production representatives in Mexico, such as Fishing Coordinators, and Federal Government Aquaculture, responsible for the fishing commissions and Aquacultural Sanity Committees managers, this last organism groups the producers in each entity. The intention is to come closer to this organism was to get to know the actual state that presents the sector and the linking among the diverse actors, see table no. 3

Table 3: Entrevistas realizadas en investigación de campo en la región centro occidente de México

Entidad	Cargo	Persona entrevistada	Producto en cultivo	Sector
Colima				
Dirección de Pesca y Acuicultura		Dra. Claudia García Olea	Coordinación	Gobierno Estatal
Subdelegación de Pesca de Colima		Mtra. Elena Telina Cárdenas Zermeño	Coordinación	Gobierno Federal
Comité de Sanidad Acuícola		Ing. Jose Antonio Fernandez Meneses	Coordinación	Empresarial
Granja el bagre		Ing. Oscar Jauregui Quince	Tilapia y Camarón	Empresarial
Granja Acuafutas		Mtro. Carlos Hernández Solórzano	Camarón	Empresarial
Centro Acuícola de Jala		Mtro. Maximiliano Sánchez Barajas	Tilapia	Gobierno
Jalisco				
Coordinación de Pesca y Acuicultura		Mtro. Rubén	Coordinación	Gobierno Estatal
Centro Ranícola El Estribón		Tec. José Jaime Ruvalcaba Pérez	Rana Toro	Gobierno Estatal
Centro Acuicola Las Peñas		Biol. Elvia Luano Torres	Tilapia	Gobierno Estatal
Comité de Sanidad Acuícola		Mtro. Julio Cesar López Martínez	Coordinación	Empresarial
Granja Tilapia Rancho Las Tortugas		Ing. Guillermo Haro	Tilapia	Empresarial
Granja de Rana Violeta		Evangelina Contreras Navarro	Rana Toro	Empresarial
Granja Hacienda Guadalupe		Alvaro Jiménez Gómez	Tilapia	Empresarial
Granja Yahualica		Ing. Francisco Javier Becerra Zamorano	Tilapia	Empresarial
Michoacán				
Subdelegación de Pesca SAGARPA		Biol. José Antonio Ortega Varela	Coordinación	Gobierno Federal
Comisión de Pesca		M.C. Julio Vargas Medina	Coordinación	Gobierno Estatal
Comité de Sanidad Acuícola		Biol. Erick Barriga Tovar	Coordinación	Empresarial
Granja El Paraíso		Sr. Abel y Sra. Gema	Trucha y Rana Toro	Empresarial
Granja Cooperativa Emiliano Zapata		Sr. Alberto García Rodríguez	Tilapia	Empresarial
Granja La Consentida		José Fabián Guerrero López	Rana Toro	
Cooperativa de Producción Pesquera Huingo-Araró		Biol. Baltazar Castro Zarco	Tilapia y Rana Toro	Empresarial
Nayarit				
Subdelegación de Pesca SAGARPA		Ing. Francisco Javier Ramos García	Coordinación	Gobierno Federal
Secretaría de Desarrollo Rural y Medio Ambiente		Mtra. Maria de Lourdes Bernal Acosta	Coordinación	Gobierno Estatal
Comité de Sanidad Acuícola		Biol. Damián Pablo Rosas	Coordinación	Empresarial
Granja CUMASA Grupo Torres		Biol. Juan Manuel Polanco Guerrero	Camarón	Empresarial
Fuente: elaboración de los autores a partir de investigación de campo, México, 2018.				

In Chile, on October the same year, they received the visit of the Subdirección Nacional de Acuicultura del Servicio Nacional de Pesca y Acuicultura, the Instituto Nacional de Estadísticas de Chile, and the company organization Salmón Chile, this last one is formed by 43 partners who belong to national and multinational companies, from which 10 are companies that produce and/ or export, 9 fish farms and egg producer, and 24 laboratory sector

producers, feeding plants, pharmaceutical, logistic services and equipment, transportation, containers, and veterinarians. Furthermore, we interview Aquacultural companies' representatives in Chile, like Camanchaca, Caleta Bay, Cermaq, Cook Aquaculture, Nova Austral, Nazca Oceanografía, and Invermar, see table no. 4

Table 4: Entrevistas realizadas en investigación de campo en la region Lagos, chille

Cargo / Empresa	Persona Entrevistada	Producto en Cultivo	Sector
Servicio Nacional de Pesca y Acuicultura	Ing. Ruth Alarcón Gatica	Coordinación	Gobierno Central
Instituto Nacional de Estadísticas	Ing. Roberto Villaroel	Coordinación	Gobierno Central
Salmón Chile	Lic. Arturo Clemente	Salmón	Empresarial
Camanchaca	Lic. Liliana Muriño	Salmón	Empresarial
Caleta Bay	Ing. Roberto Abello	Trucha	Empresarial
Cermaq	Mtro. Augusto Sotomayor	Salmón	Empresarial
Cooke Aquaculture	Lic. Johana Alvarez	Salmón	Empresarial
Nova Austral	Lic. Carolina Palma	Salmón	Empresarial
Nazca Oceanografía	Oc. Jorge Alvarez	Salmón	Empresarial
Invermar	Lic. Malú Acosta	Salmón	Empresarial
Fuente: elaboración de los autores a partir de investigación de campo, Chile, 2018.			

Rules and normativity in aquacultural farms and companies in Mexico and Chile

An important aspect of the aquacultural impulse in both countries is the normativity jury frame for the development of this activity, in Mexico article 27° from the Constitución Política de los Estados Unidos Mexicanos, establishes that the national sovereignty of the natural resources, seas, rivers, lakes, mangroves, among others; likewise, it has the following reglementary laws:

- a. Sustainable Fishing and Aquaculture General Law (LGPAS), “its objective is to manage and foster the use of the fishing and aquicultural resources in the national territory and the areas where the nation has its sovereignty and jurisdiction”.
- b. Rural Development and Sustainability Law (LDRS), “promoting the rural development and sustainability of the country, promotes an appropriate environment”.
- c. National Water Law (LAN), “it regulates the exploitation, use, and harnessing of water, its distribution, and control, as the preservation of its quantity and quality to accomplish the sustainable integral development”.
- d. Ecological Balance and Environment Protection General Law (LGEEPA), “it promotes the sustainable development and establishes the bases to guarantee every person’s right to live in a healthy environment for a healthy development and

well-being, define the principle of the environmental politics, preservation, restauration and environmental improvement, preservation, and biodiversity protection, and in its case the soil, water and other natural sources repair”.

The Mandatory Laws mentioned establishing the aquacultural sector operation, as long as the water used for the production center and the general rules for the environmental protection, natural resources, and sustainability. It is of general compliance for all the producers and the omission to any of these laws can cause a considerable fine that can cause temporary or definite closer to the production and/or marketing units.

In the case of Chile, there is a strict normativity despite the frequent diseases that affect the Atlantic salmon population, particularly the ISA (infectious salmon anemia) virus, viral disease that affects cropping centers of the species in Canada, Norway, Scotland, and Chile, having considerable lost, like the crisis lived in 2007 with considerable economic repercussions. The Constitución Política de la República de Chile, article 19° numeral 8 establishes that it is the State duty to teach the natural preservation, from this one the following mandatory laws are developed:

- a. Fishing and Aquaculture General Law, article 74° subsection 3, “dispose of that the maintenance of clean spaces, and ecological balance of the conceived zone, which alteration

has aquacultural activity as a cause will be responsible for the concessionaire, following the regulations that are issued"; in the same law in art. 87°. "It provides that environmental protection measures must be regulated so that aquaculture establishments operate at levels compatible with the capacities of the river and maritime lake water bodies.

- b. Environmental regulation for aquaculture, in article 1. The provisions of this regulation will apply to all types of aquaculture activity, whether it is subject to the aquaculture concessions regime, authorizations, or simply requires its registration in the National Aquaculture Registry, in the terms provided in article 67 of the General Law of Fishing and Aquaculture.

The legal system in both countries regulates the aquacultural activity in three fundamental aspects, farming regulation, harnessing, and marketing of aquacultural species. The use and availability of vital water input for aquacultural farms and the impact on the environment and sustainability. The law establishes strong economic sanctions for failure to comply with current regulations.

Aquacultural farms operational conditions

It is important to mention that there is a difference between farms in Mexico and aquacultural companies in Chile. In the case of farms, there follow unfamiliar processes without registering income and outgoings operations, even though they have a production control, which takes these organizations to work spurred by carrying the activities without a future vision of their growth. On the other hand, companies in Chile focus on the X Lagos region, Puerto Montt, most of them have corporative or managing offices, besides production centers in freshwater and saltwater.

Its international marketing perspective makes these organizations present production plans to cover the product demand worldwide, this is why these companies have one or many international certifications.

The farms visited in Mexico, in the states of Colima, Jalisco, Michoacan, and Nayarit, are located in rural or semi-urban areas, each federal entity impulses the aquacultural activity according to its weather conditions and hydraulic resources, for example, in Colima tilapia and shrimp; in Jalisco tilapia, bullfrog, and ornament fish; Michoacan tilapia, trout, and bullfrog; Nayarit shrimp and tilapia.

Their processes are carried on rudimentary practices, in open-sky swamps, aeration paddles, and in some cases with production technology, automatic aeration systems, and geomembrane and greenhouse-type ponds.

Only some of them, as the case in Camaglo farm in Nayarit, focus on shrimp production to export. In Michoacan and Nayarit, there are small farms that focus on the auto consumption productions or regional distribution or national wide to the Sea marketplace La Viga, in CDMX, and Sea marketplace in Zapopan, and Guadalajara, Jalisco.

In Chile, aquacultural companies are formally established, they are regulated by the Central government, with regional offices to supervise and watch directly, at least twice a year, the organisms' production and identify in advance any pathology that they may present, as mentioned before, the constant concern of shoots of

the ISA virus that can affect the economic and financial expected results.

Chilean aquacultural companies make electronic registers, manual formal managing processes, production, marketing, and control, which allows them to plan operational and strategically, production centers are separated from their managing offices which facilitates establishing permanent evaluation of the objectives and goals previously traced.

Farms in the occidental region of Mexico

COLIMA: This Federal Entity is one of the smallest in the Central Occidental Region of Mexico, it is located in the Pacific Ocean, it has one of the most important ports at a national and international level, Manzanillo, because of its weather conditions it has developed 25 shrimp farms, mainly located in Tecomán and Armeria, and 60 tilapia farms, (SADER, Colima, 2018).

The following farms were visited: "El Bagre" shrimp and tilapia; Acuafutas, shrimp; and the Aquacultural Production Center of the State of Colima of Jala. Next, we present the most relevant data from the production units operation mentioned before.

El Bagre and Acuafutas are intense shrimp production farms that have normally operated for years, with the problems that concern most producers, pond aeration, difficulties in finding enough water, lack of technology, lack of biological goods (shrimp and juvenile larvae).

Nonetheless, from the Aquacultural Sanity Committee meetings, sharing experiences and presenting the results for the practice visits to watch the sanity conditions for the organism's production that has to maintain an adequate sector interrelationship.

The Aquacultural Production Center of Jala dedicates to fatten and selling tilapia for its restocking that takes care of thirty producers of Colima and Jalisco through the subsidy, lowering the tilapia price until 40% approximately, Juvenile as well as receive calves. It has maintained permanent contact with producers for more than years which allows to exist a permanent development of the aquacultural activity in the state and neighboring entities.

JALISCO. State of Mexico with large territorial extension, coast resources, and water bodies, the principal aquacultural products are tilapia, bullfrog, and ornament fish. The aquacultural activity develops in all the state regions through Aquacultural Centers that belong to the State of Jalisco, having a big concentration of farms in Costa Alegre, Melaque, Barra de Navidad, Tomatlan, and Puerto Vallarta.

The farms visited for the interviews were Granja Acuicola Las Tortugas in Colotlán; Granja Ranícola Violeta in Atotonilco; Granja Acuicola Los Altos in Yahualica; Granja Hacienda Guadalupe, La Barca-San Miguel highway; Centro Acuicola del Gobierno de Jalisco, Las Peñas en Huejúcar; and Centro Ranícola El Estribón, Gobierno de Jalisco.

The tilapia and bullfrog farms visited have a normal function, with the main problems these type of undertakings have, lack of financial resources, high-price power service, lack of farm technology to recirculate water and air in the swamps, lack of technical support, in spite of the support that the Aquacultural Sanity Committee bring to determine the health level that the organisms present.

Some recommendations that aquaculture workers present are the need for teamwork with the producers to obtain collective benefits, having investments to improve the farm's financial

operation, because it is considered to be a profitable business, but additional resources are needed to improve the farm operational conditions.

The aquacultural and frog centers that belong to the State of Jalisco have an important function to help to impulse the entity's activity, offering breeding to start these types of farms or restocking for those who are in permanent activity. The consultancy that the production centers bring is important but not enough as they orient and go to the regional farms which are insufficient due to the amount of work to accomplish.

MICHOACAN: This is a state with important aquifer resources, it has a great number of farms in different regions of the entity. Nonetheless, most of them focus on auto consumption or marketing in areas where they are located. Some farms belong to fishing and aquacultural cooperatives, its orientation has been social support to low-income popularity, promoting self-employment and resources generation for families in rural and semi-urban areas. The principal aquacultural products cultivated are trout, tilapia, and bullfrog.

The farms visited were El Paraíso, Morelia; Cooperativa Emiliano Zapata, Granja La Consentida, and Cooperativa de Producción Huingo-Araró; these farms function in a natural way like a family business or a partner association (cooperative). In the case of "El Paraíso" farm, it is located in a mountain spot with small rivers which is a benefit because of the water temperature and the place condition, the simultaneous production of the rainbow trout and the bullfrog, the owners have received permanent support from the Aquacultural Sanitary Committee of Michoacan to improve the operational conditions of the farm. Besides, the aquacultural activity gets stronger with a restaurant where the dishes prepared with the cultivated farm products are sold.

Farms Emiliano Zapata, La Consentida, and La Cooperativa de Producción de Huingo-Araró are production centers worked by the partners. They mixed tilapia and bullfrog production, nonetheless one of the main problems is facing the lack of a partnership culture and teamwork that benefits all, besides the constant farm operations there are occasions when their members do not take part in the activities to accomplish or to give resources to improve the farm functioning.

Nayarit: This State has its natural resources, because of its warm weather which predominates most of the year, its average temperature is 30°C. However, the economic activity concentration is in the State capital, Tepic, this is why many of the farms are in rural areas, in water bodies, near the coastal area. The current aquacultural farms belong to the social and private sector, there are 586 in the State, shrimp 535, tilapia 47, and others 4; they are in the two edges, very small auto consumption farms or farms-companies which orientation is the product exportation (shrimp). They are integrated into local boards: north area Acaponeta and Tecuala (61 production units); center area Tuxpan (203 production units); Santiago (14 production units). Tepic, Compostela, Ahuacatlán, Jalisco.

One of the main problems in the aquacultural activity in the entity has been the disorganized growth of production units, with lots of ponds, water does not recirculate which makes diseases for the shrimp.

Likewise, the technology level in most of the cases is rudimentary, with swamps made in an open-sky board, few of them have cutting-edge technology, only big exporting farms

apply technology in their processes, among these high-technology farms are Camaronicola la Gloria y Aqua In.

Aquacultural companies in Chile

In this country, we contacted many companies that belong to the region X Lagos, Camanchaca, Caleta Bay, Cermak, Cooke Aquaculture, Nova Austral, Nazca Oceanografía e Invermar, the most important finding on the interviews made to the representatives are presented next.

Camanchaca: This is a holding, with three divisions, fishing, mollusks, and salmon, it has a presence in different regions in the country, corporate offices and sells on Santiago; fishing North plant in Iquique; abalones plant Caldera; fishing South plant Isla Roquant; Sells point Coronel; salmon cropping center Puelche; salmon cropping center Mañihueico; Salmon office Puerto Montt; primary process plant San José; oysters cropping center Caucahué; oysters cropping center Puyao; oyster farming center Chequián, and sells point Rauco; internationally they have a presence in marketing offices and distribution in Mexico City, Miami U.S.A., Spain (for Europe), China and Japan.

Their products are exported to 60 countries in the five continents, to accomplish their activities they have 3821 employees distributed around their installation all over the world.

Camanchaca Salmon, a company with national family origins, is affiliated to Camanchaca S.A., with Chilean and Norwegian capital, it has 5 pisciculture of freshwater, 73 aquacultural concessions to sea cropping, and 2 process plants to develop its productive process labor, which is located since the VIII to the XI region. It has 5 marketing offices and representatives in Mexico, United States, Europe, China, and Japan; the company has 1831 employees, mainly operational and technical personnel. The 80% of salmon production ends in the international market mainly in Argentina, Brazil, China, United States, Japan, and Russia, for this reason, it is important to have the ISO14001 and 14004 certifications (requirements to formulate and maintain a management environmental system) and occupational safety certification, OHSAS 18000 and 18001 (base system for health and job security). Trout outsourced production for Caleta Bay.

Cermaq: is a global leader company that takes part of the Mitsubishi Corporation group with a site in Tokyo, Japan, with salmon farms in Canada, Chile, and Norway (main site); in Chile, it has 44 production centers in seawater, 10 pisciculture, and 3 plants. The three principal cultivating species are coho salmon, Atlantic salmon, and trout.

The average of employees in a peak season comes to 6000, in mid-season from 1400 to 1500 mainly in the technical and operational areas.

Their products are mostly delivered in large percentages to the United States, Brazil (coho and Atlantic salmon), and Japan (trout); they adapt to the certification that each country requires. In the last years, the company has focused on creating a sustainable process, putting special emphasis on water recirculation to avoid pollution and salmon diseases.

Cooke Aquaculture is a company with national family origins, currently is an aquacultural corporation integrated vertically with a site in Blacks Harbour, New Brunswick, Canadá; with operational salmon farming in Atlantic, Canada; United States (Maine and Washington), Chile and Scotland, along with the sea bass and sea bream farming operations in Spain.

In their workforce, there are 1200 employees, 350 by contract and the rest outsourcing, they have a process plant in Puerto Montt and a fjord* in Aysén region XI of Chile. 100% of production is for exportation.

Fjord: It is a land relief located on the coast and of an abrupt type, like a cliff or a strait. The fjords have an especially narrow strip of sea, of a significant depth and can reach several kilometers.

The products that are in the worldwide market have to be certified according to the destination country, among other rules there is HACCP, which contributes to the rule ISO22000, requirement to control the risks of feeding security; rule BRC (British Retail Consortium); rule Global G.A.P. (Good Agricultural Practices) which guarantees the good agricultural practices; rule KOSHER, which makes sure that the products follow the Jewish religious rules.

The Balanced Scorecard is not used at the moment, because of this there is no tracking of the results, staff training is an important aspect for the company, it is highly important that the staff is up to date with the certifications' normative aspects and to establish a career plan for the collaborators.

Nova Austral international company with Norwegian capital, with more than 15 years of operation in the Magallanes Region and the Chilean Antarctic, located in the Punta Arenas zone, in Porvenir, Tierra de Fuego, regions 10 and 12 respectively. Its main customers are the United States, Germany, and Russia.

Due to the weather characteristics in the region, stable and low-temperature water during the year of the production centers in the sea provides sustainable conditions to crop salmon with the highest standards.

Salmon is cropped in terms of nature as they never treated them with antibiotics. There are neither hormones nor chemical substances added to be in harmony with the environment in a sustainable way.

They organize a permanent development program along with their collaborators in the educational, infrastructure, sports, recreation, social attention, community action, technical training area, as well as a grant-aided home building program.

The company has different certifications among them are ASC (Aquaculture Stewardship Council), certification program and labeled, it manages the world standards for responsible aquaculture, rule BAP (Best Aquaculture Practices), fishing products processing plants certification, rule HACCP, it contributes to the implementation of rule ISO22000, requirements for food safety risk control and rule IFS (International Featured Standard), it certifies the security and quality of the processed food products and the production processes.

Caleta Bay is a company with national family origins that started in 1985 with the first trout pisciculture on the shore of Pitreño river, Ranco Lake; in 1989, Caleta Bay incubated 250,000 Pacific U.S.A. salmon eggs; in 1990, it leased out the Rupancho Lake concession; in 1997, the company created the Punta Terapio Center in Cochamó; in 2015, it acquired a process plant with a capacity to fillet more than 50,000 trout daily; in 2016, the exportation to the U.S.A. began; in 2017, it opened a new marketing office in Tokyo, Japan as well as a research and reproduction center; in 2018, the managing of Caleta Bay is transferred from Osorno to Puerto Montt; in the same year, it

opened the Pacific salmon eggs incubator; finally, in 2019, it opened a new process plant in Puerto Montt to process the total production and sell the products to the community.

Its installations are distributed in the south of Chile, process offices and plants in Puerto Montt; cropping freshwater centers: Mantihue, Rupancho Lake, Llanquihue Lake, and Cochamó; cropping sea water centers: Cochamó (5), Puelo (7), Calbuco (1), Hualaihue (2), Hornopirén (1), Cholgo (2), Caleta Gonzalo (1).

Most of its products are exported to Asia and North America, Japan 65%; USA-Canada 27%, Asia 3%, Russia 3%; to internationally commercialize it must have different certifications some of them previously mentioned, such as BAP, BRC, GLOBAL G.A.P, HALAL, IFS, KOSHER, and ASC; additionally, BVC (Bureau Veritas Certification) Huella Chile, FDA (Food and Drug Administration), Hazard Analysis and Critical Control Points.

Invermar Chile is a national capital company, open to the stock market, its principal capitalist partner is a Chilean family, it has an alliance with the Mexican company ALIMAR. INVERMAR constitutes a vertical integration holding with different companies, cropping, harvest, food, process, transportation, among others; besides the INVERMAR group manages different types of business such as papers, cartons, miner, banks, painting, among others.

The main cropping products are Atlantic salmon, coho salmon, and oysters (Ostimar); they generate added value products in frozen portions that will be delivered to the international market in the United States, Mexico, Canada, and Europe, their corporative marketing offices, exterior market and managing are in Santiago; the production area, cropping centers, internal logistics, and human resources are in Puerto Montt, with process plants in Chile and Castro.

The company's certifications are ISO9001 and ISO22000, norm CHHCCP (dangers and critical points analysis, international norm based on the safe food production with a preventive closer; code EPC (electric products code), it allows the independent identification of any object; norm GLOBAL G.A.P. (worldwide norm for the good agricultural practices); norm ASC (Aquaculture Stewardship Council) it covers the principals and criteria to minimize the environmental and social impacts key in aquaculture.

Productive articulation in aquacultural farms in Mexico and Chile

The aquaculture in the Central Occidental Region of Mexico, (Colima, Jalisco, Michoacán, and Nayarit), registers a significant advance due to the sustainable growth of the sector in the last 10 years. Nonetheless, the productive articulation level to establish permanent relationships, among different actors, entrepreneurs, govern representatives, educational institutions of higher education, research centers, producers' associations, suppliers, and service providers, for the grouping development, is still emerging, besides most of the farms are more oriented to local growth, only in some case they focused on the exportation to the United States and Japan.

The intervention of the government organisms, Comisión Nacional de Pesca y Acuicultura through their representatives, and the Fishing commissions or administrations in the federal entities mentioned before, regulate the farms' function, this is to watch regulatory compliance, besides it provides economical

support in different aspects such as business plan formulation, equipment, purchase biological inputs (eggs, larva o juvenile), combustible or electric power subsidy, among others.

Another organism that takes part in supporting aquacultural farms in terms of sanity and food safety is SENASICA, its function is vital to avoid organisms' disease spread and watch that the fresh products or value-added products that are commercialized for human consumption agree with the official norm and international standards.

An important element for the sector's interaction is the input system of tilapia, shrimp, trout, and bullfrog which substitutes the productive chain scheme, coordinated by SAGARPA (now SADER), to each of the products mentioned, to make actions tented to continuously stimulate the sector members' participation and involve them in a constant enhancement.

The Academic participation through the Universities and Technology High-Education Institutions and Research Center is sporadic, only for guided visits or production process understanding, permanent activities with applied research projects are not conducted, likewise, foreign researchers occasionally attend to visit some farms, but this does not translate into joint activities to improve the sector.

Despite observing a relative integration of the productive grouping actors, the cluster formation (Porter), and the triple model interaction (Etzkenowitz) and the quadruple helix still require a major involvement of all its members and focusing on a continuous collaboration work in areas like research, marketing and exchanges with international level sector specialist.

The food, medicine, equipment, and machinery suppliers perform a marketing relationship, which does not represent the liability that the certification demands to aquacultural medium and big companies to sign work contracts.

In the case of Region X Puerto Montt in Chile, a major productive articulation is presented among aquacultural companies formally established and other group members, the organizations that were chosen for the research possess corporative offices, production centers, and production plants, which initially allows accomplishing an interrelationship among different agencies that integrate them, the interrelationship level among the sector members present through the SERNAPESCA and Salmón Chile intervention, to supervise the normative aspects, sanity and

innocuousness for their products' marketing at an international level.

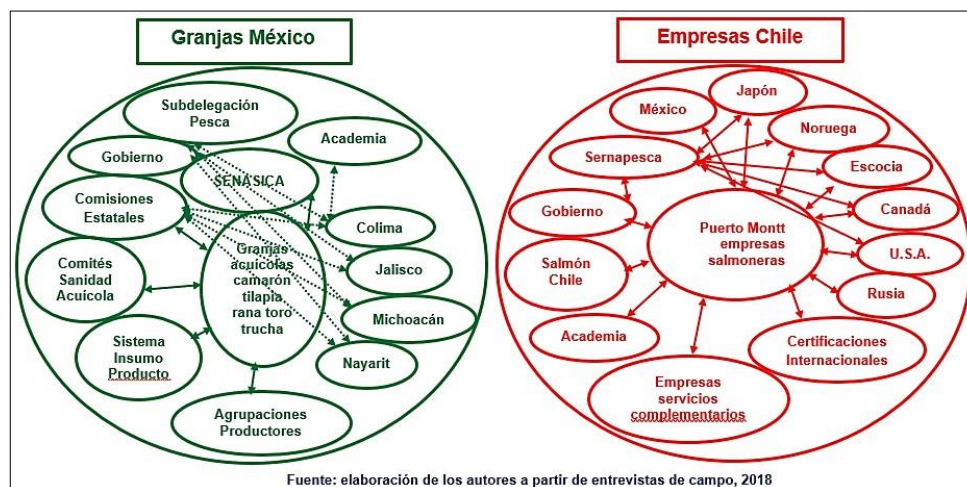
Companies perform marketing alliances that can be perceived as companies' nets (Lopez) with organizations of diverse sizes integrated horizontally and vertically, it can be as cropping products' suppliers, salmon, and trout; or with additional transportation services of living products well boats; equipment and machinery suppliers; food, medicine, and biological inputs suppliers; monitor services, to supervise the sea cages and dive for the underwater infrastructure failure detection; in some cases, the imported biological input purchase coming from Norway, Scotland, or Canada; fresh frozen product transportation to the process plants and logistic services in general for the distribution and marketing of international products.

The most important corporate body which clusters 80% of the aquacultural companies is Salmón Chile in charge of advising its associates in sanitary, environmental, normative, social, and economic aspects, nationally as internationally, supporting sustainability and the community link where the companies are located, among them are Cooke Aquaculture Chile, Salmones Camanchaca, Cermaq Chile, and Nova Austral, despite the grouping importance they are oriented to the distribution and marketing and keep a relative distance with SERNAPESCA and another government organism.

The relationship of salmon companies with higher educational institutions, research centers, and specialized organisms is occasional, only guided visits, process understanding, and specialized research projects, some of them sustain exchange programs with Universidad Austral and Universidad de Los Lagos.

Summing up, it is important to mention that the productive articulation requires the intervention of various sectors, corporate, government, academic, and social, permanently and with clear objectives that are common to its members to accomplish important benefits that allow the harmonic development and enables its orientation to internationalization, see figure no. 4

The organizations' certifications with international norms worldwide force companies to keep a performance standard in which interaction among actors is required to share requirements and place its products in different countries.



Fuente: elaboración de los autores a partir de entrevistas de campo, 2018

Fig 4: Articulation productive sector acuicola

Conclusions

Based on the objective of this document, analyzing the regulation, operational conditions, and the productive articulation degree in networks or cluster of aquacultural companies and their orientation to internationalization and marketing of aquacultural products, we may consider the following:

Regarding the aquacultural matter regulation to the function in Mexican farms and Chilean companies that can be found in the existing organisms at a federal level SAGARPA (SADER) and SERNAPESCA, and to a local level in regions of each country such as state offices or regional coordination in both countries respectively; in the case of Mexico, they count with additional organisms such as Aquacultural Sanity Committee and SENASICA (National Service of Sanity, Safety, and Food Grade), whom regularly monitors the operating conditions of the company bodies. In the case of Chile, we emphasize the sector sustainability due to previous experiences of organisms' diseases which have caused significant loss in the country's economy, (ISA virus 2007).

The farm operational conditions in Mexico are basic, most of them do not have formal production registration, incomes, and expenses, they do some improvised work, with an auto-consumption orientation from the locations where they are and few companies in the all the Centro Occidente region in Mexico orient their products' exportation, essentially they distribute to a local level, some deliver in national sea marketplaces, such as Mercado de la Viga in Mexico City, and Sea marketplaces in Guadalajara, Jalisco.

The Chilean aquacultural companies are formally established, they have independent corporative offices in the production centers and the process plants, they have an approach to the international market towards the United States, Japan, Norway, Canada, China, Scotland, Russia, and Mexico, among others so the cropping, harvest, and commercialization is achieved through the vertical and horizontal orientation, incorporating the affiliated companies and other companies that provide complementary services, the companies are taken into account for the research (convenience sample), they are part of a corporative at international level with sites in different countries, U.S.A., Norway, Japan, and Mexico.

In the case of Mexico, aquacultural companies operate with elementary enterprise networks, integrating companies vertically in the supply of biological inputs, medicine, and the provision of complementary services, likewise the institutional producers' relationships in each of the federal entities taken into account for the research, most of their members attend regularly only when it is necessary to apply for credit or technical support to solve a specific problem.

The productive articulation is more advance in Chile, mostly in the enterprise networks modality, it has been considered through the years, because of their link to an international level and the tendency to their products' exportation, with sporadic relationships with the academy and the government, importantly in the fourth helix through organizations such as Salón Chile; the companies with international certifications from the destination countries force considerable improvements to accomplish the client's expectations but mostly to meet the requirements of today's world.

Concluding comments

The trend towards the year 2050 is the production of organisms in control environments due to the meager harvest of organisms in nature, aquacultural farms, and companies in Mexico and Chile, they need to find better ways to crop, harvest, distribute and commercialize their products, departing from more efficient and successful processes, always considering their national and international development.

The productive articulation is not only an option but a new way of making business in a world level mostly in all the primary sector companies, developing strategic partnerships for the enterprise networks consolidation, but also the creation of clusters oriented to the innovation and technological development, to improve the survival and endurance of the species, above all the sustainability and maintainability of the sector.

The aquacultural farms and companies in Mexico and Chile will be oriented to the international standards compliance to place their products in other countries around the world.

The future research areas derived from this inquest will allow us to keep analyzing the behavior of other similar companies around the world and to offer solutions for the academy, government, producer associations, and companies to prepare the aquacultural sector for the challenges of the coming decades.

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