Tilapia as a global commodity; a potential role for Mexico?

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By

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Declaration

I hereby declare that this thesis has been composed entirely by myself and has not been previously submitted for any other degree or qualification.

The work of which it is a record has been performed by myself, and all sources of information have been specifically acknowledged.

Adrian G. Hartley-Alcocer

Date

To the tilapia farmers in Mexico

In loving memory of my grandfather

To everyone involved in this research and my life during my studies

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Abstract

The potential for commercial tilapia aquaculture to be developed taking an economic-focused approach was investigated in Mexico. The research examined various issues related to production, marketing and the business environment of the industry.

Findings revealed that farmed tilapia products in Mexico can be produced competitively and profitably in large quantities, not only due to its suitability for culture in most of the country; but also due to the availability of more profitable markets (i.e. supermarkets), increasing demand for high quality tilapia products (e.g. fresh, large sizes and more value-added products) and implementation of more efficient business strategies (e.g. economies of scale and partnerships) and newer technologies (i.e. husbandry and equipment).

Public/private sector partnerships proved to be the most feasible way to promote and develop tilapia farming in Mexico, particularly in the case of small and medium enterprises (SMEs). Through either economical, technological or consumables support from development bodies; and integration with other agri-business (e.g. agriculture and livestock) or within the industry (i.e. horizontally and/or vertically). In which economies of scale were promoted, efficiency was improved, dealing power was increased, and costs and risks were reduced. In which larger businesses reported production costs 50% lower (around MX 11 kg^{-1}) than SMEs, allowing them to compete against larger sources (i.e. fisheries and imports).

Additionally, a strong and fast moving domestic market influenced by the decline outputs (22% between 1990 and 2003) from the main source (i.e. catching sector) and the availability of more value-added products (e.g. fillets in various presentations) have promoted its expansion into more profitable markets (i.e. supermarkets and exports) and in sustained and/or increased prices within the past decade (compared to other seafood commodities, e.g. shrimp and salmon).

However, concerns arise about the long–term sustainability of tilapia farming due to the high production costs (overall median value MX$ 19 kg^{-1}), small and inconsistent outputs (85% of the farms interviewed produced less than 100 t $year^{-1}$), lack of knowledge of proper farming techniques and marketing strategies, unlawful competition from imported products (labelling and taxes), poor law enforcement and monitoring from regulatory institutions, and poor institutional support and inadequate extension services, all of which have affected the sustainable development of tilapia farmers and associated groups.

Further research is required for the development and promotion of more efficient and economically viable strategies for tilapia farming businesses to target key internal markets. Similarly, improved and more rigorous monitoring of development and support programs performance is required.

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List of Abbreviations

ANTAD	Asociación Nacional de Tiendas de Autoservicio y Departamentales (National Supermarket Association)
BANCOMEXT	Banco de Comercio Exterior (Exterior Commerce Bank)
BANCRUGO	Banco de Crédito Rural del Golfo (Gulf Rural Credit Bank)
BANRURAL	Banco Nacional de Crédito Rural (National Bank of Rural Credit)
BANXICO	Banco de México (Bank of Mexico)
CANAIPESCA	Cámara Nacional de la Industria Pesquera y Acuícola (Fisheries and Aquaculture Industry National Chamber)
CESASIN	Comité Estatal de Sanidad del Estado de Sinaloa (Sinaloa's Aquaculture Health State Committee)
CESUES	Centro de Estudios Superiores del Estado de Sonora (State of Sonora Higher Education Centre)
CEVIA	Centro Virtual de Información del Agua (Virtual Water Information Centre)
CIA	Central Intelligence Agency
CIAD	Centro de Investigación en Alimentación y Desarrollo (Food and Development Research Centre)
CICOPLAFEST	Inter-Secretarial Commission for the Control of the Processing and Use of Pesticides, Fertilizers and Toxic Substances
CINVESTAV	Centro de Investigación y de Estudios Avanzados del IPN (Research and Advanced Studies Centre of IPN)
CISESE	Centro de Investigación Científica y de Educación Superior de Ensenada (Scientific Research and Higher Education Centre of Ensenada)
CNA	Comisión Nacional del Agua (National Water Commission).
CNIE	Comisión Nacional de Inversión Extranjera (National Commission of Foreign Investment)
CNP	Carta Nacional Pesquera (National Fisheries Magazine)
COMEPESCA	Concejo Mexicano para la Promoción de Productos Pesqueros y Acuícolas (Mexican Council for the Promotion of Fishery and Aquaculture Products)

CONACYT	Consejo Nacional de Ciencia y Tecnología (National Council of Science and Technology)
CONAPESCA	Comisión Nacional de Pesca (National Fisheries Commission)
COVECA	Comisión Veracruzana de Comercialización Agropecuaria (Veracruz Agricultural Trade Commission)
CR	Concentration Ratio
cu	Cubic
DFID	UK Department for International Development
DGIE	Dirección General de Inversión Extranjera (General Office of Foreign Investment)
DOF	Diario Oficial de la Federación (Official Newspaper of the Federation)
ECOSUR	Colegio de la Frontera Sur (South Border College)
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPOMEX	Centro de Ecología, Pesquerías y Oceanografía del Golfo de México (Gulf of Mexico Ecology, Fisheries and Oceanography Centre)
EU	European Union
FAO	Food and Agriculture Organization
FCR	Food Conversion Ratio
FDA	Food and Drugs Administration
FIDI	Fishery Information Data and Statistics Unit
FIGIS	Fisheries Global Information Systems
FIRA	Fideicomisos Instituidos en Relación con la Agricultura (Agriculture Related Established Funds)
FIRCO	Fideicomiso de Riesgo Compartido (Shared Risk Trusteeship)
FIRI	Inland Water Resources and Aquaculture Service
FOCIR	Fondo de Capitalización e Inversión del Sector Rural (Capitalization Fund for Rural Investment)
FONAES	Fundo Nacional de Apoyo para las Empresas de Solidaridad (National Fund to Support Solidarity Enterprises)

FOPESCA	Fondo de Garantía y Fomento para las Actividades Pesqueras (Fund of Guarantee and Promotion for Fishery Activities)
FTA	Free Trade Agreement
FTNP	Fisheries Total National Production
g	Grams
GDP	Gross domestic Product, the total value of goods and services produced by a country in a year
GNI	Gross National Income
GNP	Gross National Product, the total value of goods and services produced by a country in one year, including profits made in foreign countries
ha	Hectare
HACCP	Hazard Analysis and Critical Control Points
HDI	Human Development Index
HHI	Herfindahl-Hirschman Index
IAES	Instituto de Acuacultura del Estado de Sonora (Aquaculture Institute of the State of Sonora)
ICLARM	International Centre for Living Aquatic Resources Management
ICOLD	International Commission on Large Dams
IMF	International Monetary Fund
INEGI	Instituto Nacional de Estadística, Geografía e Informática (Statistics, Geography, and Information National Institute)
INIFAP	Instituto Nacional de Investigación Agrícola, Ganadero y Forestal (Agriculture, Livestock, and Forestry Investigation National Institute)
INIRENA	Instituto de Investigaciones sobre los Recursos Naturales (Natural Resources Research Institute)
INP	Instituto Nacional de Pesca (National Fisheries Institute)
IQF	Individually Quick-Frozen
IRS	Internal Revenue Service
ISO	International Organization for Standardization
ITMAR	Instituto Tecnológico del Mar (Technological Institute of the Sea)

kg	Kilograms
km	Kilometres
lb	Pound
LCD	Least Developed Countries
m	Metre
m.o.s.l.n.	Metres Over the Sea Level
Mm	Million Metres
MX$	Mexican Peso
NAFIN	Nacional Financiera (National Financer)
NAFTA	North American Free Trade Agreement
Nes	Not elsewhere specified
NGO	Non-Governmental Organisation
NMFS	National Marine Fishery Service
NOAA	National Oceanic and Atmospheric Administration
NOM	Norma Oficial Mexicana (Mexican Official Norm)
OECD	Organisation for Economic Co-operation and Development
PAASIFIR	Programa de Apoyo para el Acceso al Financiamiento Rural (Rural Financing Access Support Program)
PPP	Purchasing Power Parity
PROCAMPO	Programa de Apoyos Directos para el Campo (Program of Direct Support for the Countryside)
PRONALSA	Programa Nacional de Sanidad Acuícola (National Aquatic Health Program)
RAS	Recirculation Aquaculture System
SAE	Servicio de Administración y Enajenación de Bienes (Service for the Administration and Transfer of Property)
SAGARPA	Secretaria de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food)
SDE	Secretaria de Desarrollo Económico del Estado (Economic

	Development State Secretariat)
SE	Secretaria de Economía (Ministry of Economy)
SEDESOL	Secretaria de Desarrollo Social (Social Development Secretary)
SEMARNAT	Secretaria del Medio Ambiente y Recursos Naturales (Environment and Natural Resources Secretariat)
SENASICA	Servicio Nacional de Sanidad, Inocuidad y Calidad Alimentaria (Health, Innocuity and Quality Agri-food National Service)
SHCP	Secretaria de Hacienda y Crédito Publico (Ministry of the Treasury and Public Credit)
SIAP	Sistema Integral de Información Agroalimentaria y Pesquera (Agri-food and Seafood Information Integral System)
SME	Small and Medium Enterprise
SNI	Sistema Nacional de Investigadores (Researchers National System)
SOFOLES	Sociedades Financieras de Objeto Limitado (Limited-Purpose Financial Societies)
SPSS	Statistical Package for Social Science
sq	Square
SSA	Secretaria de Salud (Ministry of Health)
t	Tonnes
UAT	Universidad Autónoma de Tamaulipas (Autonomous University of Tamaulipas)
UJAT	Universidad Juárez Autónoma de Tabasco (Juarez Autonomous University of Tabasco)
UK	United Kingdom
UN	United Nations
UNAM	Universidad Nacional Autónoma de México (National Autonomous University of Mexico)
UNDP	United Nations Development Program
US or USA	United States of America
US$ or $	US Dollars
USDA	United States Department of Agriculture

USDS	US Department of State
UV	Universidad Veracruzana (University of Veracruz)
yr	Year

Glossary of Terms

Pesquerías-Acuaculturales (Aquacultural-Fisheries)	Fisheries derived from aquaculture activities, i.e. fingerling stockings in reservoirs.
Alianza Contigo/para el Campo	Aliance with You/for the Countryside
Atarraya	Cast Net
Blanco del Nilo/Oriente/Real	White fish from the Nile/East/Royal
Cadenas de valor	Commodities Value webs
Carta Nacional Pesquera	National Fisheries Report
Ceviche	A form of citrus marinated seafood salad
Chinchorro	Seine, Sweep Net
Corral	Net pen with staked sides and allow the bottom net to rest on the bottom or forsake a bottom net altogether.
Corraleo	The action of scaring the fish towards the nets through noise with the engines or paddles.
Coyote	Common named referred to a middleman
Ejido	Communal Farm
El Niño or La Nina	Major temperature fluctuations in surface waters of the tropical Eastern Pacific Ocean
Encierro	confinements or enclosures
Estanque rustico	Pond or earthpond
Gnathostomiasis	Food-borne parasitic zoonosis
Hapa-in-pond	Cage made of mosquito net placed in a pond
Jaula	Cage
Kill-Chill	Process in which the fish is killed after harvest by placing it in water with ice.
Ley de Pesca	Fisheries Law
Mestizo	mixed European and Amerindian

Microcuenca	Small watershed system
Mojarra or Mojarra-tilapia	Terms usually employed when referring to tilapia in Mexico
Pargo cerezo	Cherry snapper
Red Agallera	Gill Net
Tortilla	A type of thin round Mexican bread made from maize flour and eggs (Cambridge Dictionary, 2005)
Trasmallo	Gill net with two or three nets in parallel

Chapter 1 Introduction

1.1 Background

According to various authors, tilapia has become an important food commodity and a fast growing industry in many countries around the world including Mexico, with aquaculture outputs becoming more important in recent years (Alceste, 2000; Alceste & Jory, 2002; Alvarez, Ramirez, & Orbe, 1999; Castillo, 2003; Engle, 1997a; Fitzsimmons, 2000a, 2003a; Hernandez, Alceste, Sanchez, Jory, Vidal & Constantin, 2001; Maclean, 1984; Morales, 1991; Young & Muir, 2000). In Mexico, however, compared to other aquatic species, commercial tilapia aquaculture seems to be struggling to develop. As a developing country located next to one of the worlds' largest markets, patterns of rural development and market structures may be expected to change markedly over coming years, and with this, new opportunities for the sector. This thesis is concerned with production, marketing and business environment aspects for tilapia farming industry development in Mexico. The work commences by setting the background for Mexico, its resources, the industry and its markets.

1.1.1 The country's geography and political division

Mexico, with geographic coordinates of 23' 00" N, 102' 00" W, has a total area of 1,964,375 km^2 (Figure 1.1), including approximately 6,000 km^2 of islands in the Pacific Ocean, Gulf of Mexico, Caribbean Sea, and Gulf of California. To the north, Mexico shares a 3,152 km border with the United States; while on its south, Mexico shares a 956 km border with Guatemala and a 251 km border with Belize. Mexico has a 10,143 km coastline, of which 7,338 km face the Pacific Ocean and the Gulf of California, while the remaining 2,805 km front the Gulf of Mexico and the Caribbean Sea. Mexico's exclusive economic zone (EEZ), which extends 200 nautical miles off each coast, covers approximately 2.7 million km^2 (CIA, 2006; FAO, 2003a; INEGI, 2006). Mexico is a Federal Republic made up of 31 states and 1 Federal District (Mexico City) (Figure 1.1).

Each state has its own constitution and its citizens elect a governor as well as representatives to their respective state congresses (CIA, 2006; Mexican Embassy, 2005; Wikipedia Contributors, 2006a;).

Figure 1.1 Political map of Mexico and major cities (GEOATLAS, 2000).

1.1.2 Demographics and social issues

Over three-quarters of Mexico's estimated 103 million people, live in cities or towns with populations above 250,000 (INEGI, 2001, 2005, 2006b; Suárez, 2004). The country's top five most populated states are the state of Mexico, the Federal District, Veracruz, Jalisco and Puebla, with 14, 8.7, 7.1, 6.8 and 5.4 million inhabitants in 2005 respectively. While the largest cities, which are not necessarily located within the those states, are Mexico City (located in the Federal District and part of the State of Mexico) with an estimated population of 19.2 million, Guadalajara (Jalisco) with 4.1 million, Monterrey (Nuevo Leon) 3.7 million, Puebla (Puebla) 2.1 million, and Toluca (Mexico), Tijuana (Baja

California), Leon (Guanajuato) and Cd. Juarez (Chihuahua) between 1.6 and 1.3 million respectively (Figure 1.1) (INEGI, 2006b). The average population density is 50 persons per km^2, with regions ranging from 5,800 (Federal District) to 6 (Baja California Sur) per km2; more than double the average for North and Central America (22.4 per km^2) and 10% higher than the world average (45.8 per km^2) (FAO, 2003a; Torres, 2004; World Bank, 2003). Population growth has decreased over the past five decades, from 3% in 1950 to 1% in 2005, mainly due to declining fertility rates (from 7 children per woman in 1965 to slightly under 3 in 1998) and increased immigration (INEGI, 2001).

Mexico is a racially and ethnically diverse country. Its three main ethnic groups are "mestizos" - 60% (mixed white and Amerindian), Amerindians – 30%, and whites – 9%, plus others – 1% (CIA, 2006). After Peru, Mexico has the second largest native population within the American Continent (INEGI, 2001). Whites are mostly Spanish descendants, though also of German, Italian, French, Portuguese, British, Swedish, Irish, and from other N. American countries. The "others" largely comprise Afro-Mexicans, Middle Eastern, and East Asian. Mexico is the most populous Spanish-speaking country in the world; over 95% of the population speak Spanish, the official national language. Less than 10% speak a native language, of which there are more than 60; though highlighting due to their importance are Náhuatl, Maya, Zapoteco, Otomí, Tzeltal, and Tzotzil (CIA, 2006; Hanratty, 1997; INEGI, 2001; Wikipedia Contributors, 2006a; World Bank, 2005).

There is no official religion in Mexico, though over 92% of people practice Roman Catholicism; making it the second largest Catholic population in the world, behind Brazil and before the United States. Also, 5% of the population adheres to various Protestant/Reformation faiths (e.g. Latter-day Saints, Pentecostal, etc.), while the remaining 3% adhere to other religions or profess no religion (INEGI, 2005; CIA, 2006; Hanratty, 1997). The Virgin of Guadalupe has long been a symbol enshrining the aspirations of Mexican society. According to anthropologist Eric R. Wolf (1959), the symbol links family, politics, and religion; the colonial past and the independent present; the indigenous and the Mexican (Merrill & Miro, 1997). Religious traditions remain strong within the country and are an important factor of the Mexican economy.

1.1.3 Environment, climate and resources

Mexico has a great diversity of environments. Its tropical and sub-tropical location (within latitudes 14º 32’ and 32º 43’), together with its wide range of altitudes (up to 5,610 m.o.s.l.) (Figure 1.2), contribute to wide extremes, with temperatures range from -29ºC to 56ºC, and precipitation between two to four orders of magnitude, from 22.3 to 5,179 mm, with an average of 750 mm (Figure 1.3). The centre of Mexico is a high plateau, open to the north, with mountain chains on the east and west and with ocean-front lowlands lying outside of them (Figure 1.2). Over Mexico’s total surface area (nearly 2 million km^2), total average precipitation equals 1.5 billion m^3 of water, in which only 410,000 million m^3 drain in the surface (i.e. rivers, lakes and reservoirs); while 72% (1.19 billion m3) is lost through evaporation, seepage, and direct flow to the sea (Athie-Lambarri, 1987; FAO, 2000a). The terrain and climate vary from rocky deserts in the north to tropical rain forest in the south (Table 1.1). The Tropic of Cancer effectively divides the country into temperate and tropical zones, respectively with, cooler temperatures during winter months; and with temperatures are fairly constant year round and varying solely with elevation (Arredondo & Aguilar, 1983; FAO, 2003a; Garcia, de la Lanza & Ibañez, 2002; Hanratty, 1997; Wikipedia Contributors, 2006a).

Mexico is abundant in resources. It is the world's greatest producer of silver, and also produces zinc, lead, gold, mercury, coal, natural gas, timber and copper. However, its primary asset since the 1970s has been petroleum, with exports to the USA contributing over 70% of its revenue (CIA, 2006; Mexonline, 2006).

1.1.4 Hydrology

Mexico has many and varied water bodies with potential for tilapia production, including rivers, lakes and more importantly, reservoirs. Most of the major water bodies are in the southern states of the country. A general description is as follows.

Rivers

According to the National Water Commission (CNA, 2005), some 399 km^3 of water per year flows through Mexico's rivers, ~ 87% in the 39 major rivers (Figure 1.4), whose basins cover 58% of the country's continental land area. A total of 65% of which flow occurs in seven rivers: the Grijalva-Usumacinta, Papaloapan, Coatzacoalcos, Balsas, Pánuco, Santiago, and Tonalá, with 22% of the country's area. The Balsas and Santiago rivers empty into the Pacific Ocean, while the rest empty into the Gulf of Mexico. Further descriptions (i.e. mean surface runoff, area of basin, length) can be found in Appendix 1.

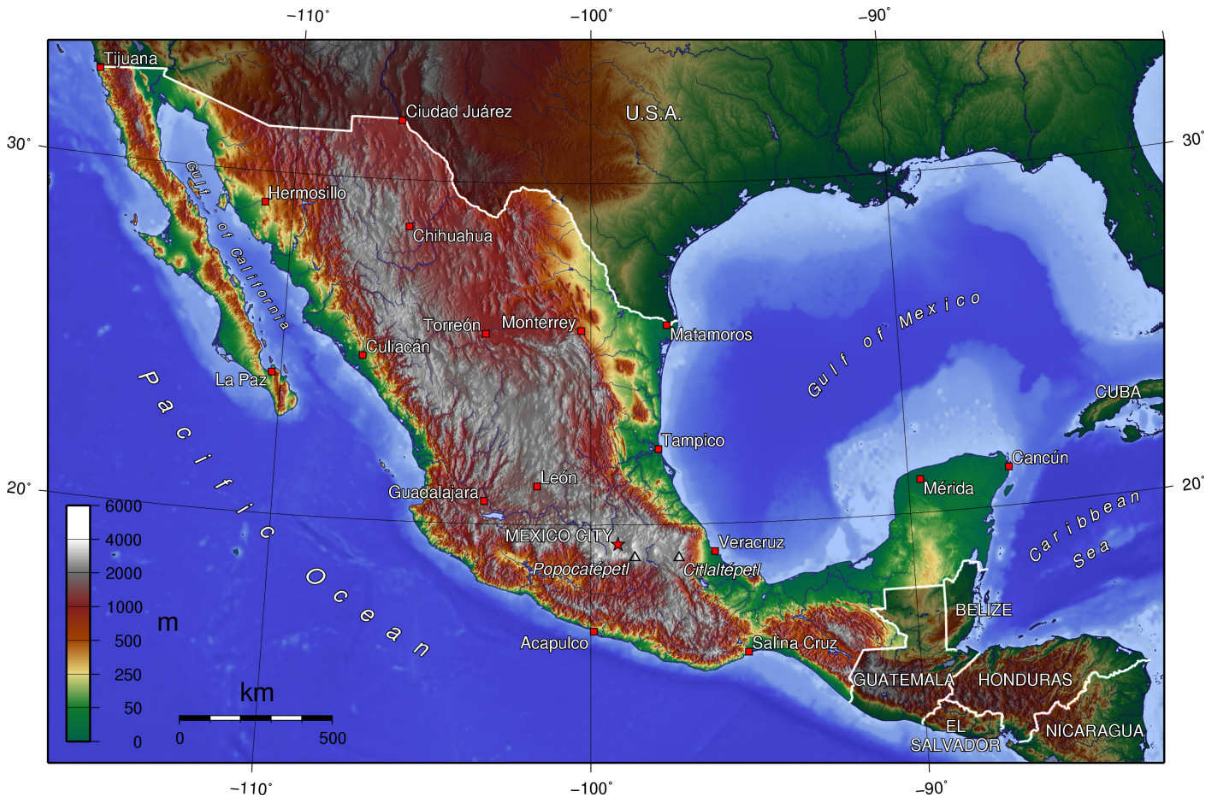

Figure 1.2 Map of Mexico's topography (Wikipedia Contributors, 2006).

Figure 1.3 **Hydrological regions of Mexico, in relation to surface drainage in mm (INEGI, 2005).**

Table 1.1 **Climatic regions in Mexico (INEGI, 2004a).**

Climate	**Surface (km^2)**	**Percentage (%)**
Hot-Humid	94,465	4.8
Hot-Subhumid	448,660	23.0
Tempered	452,003	23.1
Dry	552,700	28.3
Very Dry	405,300	20.8
TOTAL	**1,953,128**	**100.0**

Figure 1.4 Major rivers of Mexico (CNA, 2005).

Lakes

There are slightly more than 70 lakes (~ 371,000 ha of inland water bodies) and nearly 125 coastal lagoons (approx 1,000,000 ha) with volumes varying seasonally (CEVIA, 2005). Figure 1.5 shows their location and distribution, while Appendix 2 gives more details (i.e. storage capacity, area and location).

Reservoirs

The most recent inventory in the "Carta Nacional Pesquera" (National Fisheries Report) (SAGARPA, 2004a) lists 13,936 water bodies, a total of 1,165,051 ha with a very heterogeneous distribution and area. As shown in Table 1.2, 95.8% of basins fall in between the interval of 1 to 100 ha, whereas basins with the greatest dimensions account for 93.3% of total surface. Around 4,000 are dams, 667 classified as large dams as defined by the International Commission on Large Dams (ICOLD) (CNA, 2005). Table 1.3 depicts the importance of artificial reservoirs to fresh water availability. The storage capacity of the country's dams is 150 km^3 of water, 51 are particularly important and account for nearly 70% of total storage capacity (Figure 1.6). Further descriptions (i.e. capacity and purpose) are in Appendix 3.

Figure 1.5 Geographical location of major lakes (red dot), small lakes and lagoons (blue square) in Mexico (CEVIA, 2005).

Table 1.2 Classification of inland water bodies in Mexico in relation to their surface area (Pérez, Cruz, Bermúdez, Cabrera & Gutiérrez, 2002).

Category	Number (of Water Bodies)	Surface Area (ha)
Large (> 10,000 ha)	23	632,530
Medium (1,001 - 10,000 ha)	95	305,968
Small (101 - 1,000 ha)	457	146,243
Minor (11 - 100 ha)	1,589	48,243
Microbasins (1 - 10 ha)	11,771	30,077

Table 1.3 Total surface area of water bodies by type (CNA, 2005).

Type	Surface area (1,000 of km^2)
Fresh water bodies	**123**
Natural	*75*
Lakes and lagoons from the Pacific Coast	21
Lakes and lagoons from the Golf of Mexico	11
Swamps and marshes	43
Artificial	*48*
Reservoirs	48
Water bodies in lagoons, estuaries and coasts	**155**
Total	**278**

1.1.5 The government and national economy

Mexico’s recent history has been dominated by a single political party, the Institutional Revolutionary Party (PRI), which combined populism and patronage to hold on to power for more than 70 years, since 1924. However, President Ernesto Zedillo allowed much freer elections in 2000, and PRI rule ended with the election of President Vicente Fox of the mainly urban-based, market-friendly National Action Party (PAN) (Haggerty, 1989; Mexican Embassy, 2006; The Economist, 2003; Wikipedia Contributors, 2006a).

At present, Mexico has a free market economy that recently entered the trillion dollar class. Mexico contains a mixture of modern and outmoded industry and agriculture, increasingly dominated by the private sector (Torres, 2004; USDS, 2005). Its trade policy is among the most open in the world. Since the 1994 devaluation of the Peso, the government have improved macroeconomic fundamentals (Goodman, 1997; Merrill et al., 1997; Torres, 2004; Wikipedia Contributors, 2006a). A strong export sector helped to cushion the economy's decline in 1995 and led the recovery in 1996-99. Private consumption became the leading driver of growth, accompanied by increased employment and higher wages. Inflation and public sector deficits are both under control. It was not influenced by the recent South American crises, and has maintained positive, though small, rate growths after the brief stagnation of 2001. Interest rates achieved historic lows in 2001, and are still relatively low compared to last decade's rates. Inflation for 2005, around 3.3%, is the lowest in 30 years (Mella & Mercado, 2006; Torres, 2004; USDS, 2005; World Bank, 2003, 2005). As of September 2004, Moody’s, Standard & Poors, and Fitch Ratings had all issued investment-grade ratings for Mexico’s sovereign debt (Deere & Esty, 2002; OECD, 2006; Wikipedia Contributors, 2006a).

Mexico has become an important exporting and importing power. Trade with the United States and Canada has tripled since NAFTA was ratified in 1994. Mexico has also signed 12 trade agreements with 43 nations including the European Union and Japan, as well as pursuing additional trade agreements with most countries in Latin America, putting 90% of its trade under free trade regulations (Deere et al., 2002; Lederman, Maloney & Serven, 2003; USDS, 2005; Weintraub, 2004; Wikipedia Contributors, 2006a). Nevertheless, Mexico is highly dependent on the U.S., representing almost 85% of national export value, and 69% of import value in 2001, almost a quarter of the country’s GDP (Torres, 2004). Top U.S. exports include electronic equipment, motor vehicle parts, and chemicals. Top Mexican exports include petroleum, cars, and electronic equipment. There is considerable intra-company trade (USDS, 2005). This has caused the Mexican economy to be strongly linked to the U.S. business cycle, and very dependent on American economic behaviour. (Dickerson, 2005; Hufbauer & Schott, 2005; World Bank, 2005). As the U.S. economy emerged from its downturn in 2001, so has that of Mexico, growing by 4.4% in 2004 (USDS, 2005). The NAFTA agreement thus became controversial, and may have increased unemployment by debilitating domestic industries (Dickerson, 2005; Lederman et al., 2003; Weintraub, 2004).

Figure 1.6 Distribution of some of the major reservoirs in Mexico (blue triangle) (CNA, 2005).

Mexico's economy is ranked 10-14th in the world (depending on methodology used) measured as Gross Domestic Product (GDP) and Gross National Income (GNI), with a

GDP (PPP[1]) of around $1.06 trillion dollars in 2005 (CIA, 2006; IMF, 2005; World Bank, 2005). According to the World Bank (2003), income per capita is the fourth (after Argentina, Chile and Costa Rica) in Latin America if measured as GDP (PPP) and the highest if measured as GNI (US$6,790), while the country is now firmly established as a middle-income country. However, huge gaps and inequality still remain in the distribution of wealth, between the rich and poor, north and south, urban and rural, more specifically between the industrialized northern and the poor rural communities of the south-eastern states (World Bank, 2005). Mexico ranked 55 in the UNDP[2] inequality measure (2003), with a Gini Index[3] of 51.9, below Argentina, Chile, Costa Rica and Cuba. In spite of the economic disparities, Mexico is the only Latin American nation that has been admitted into the Organisation for Economic Co-operation and Development (OECD), which is composed of developed countries and three newly industrialized nations: Mexico, Turkey and South Korea (OECD, 2006; World Bank, 2005).

As shown in Table 1.4, the per capita GNI has been increasing and in 2004 amounted to US $6,790 (World Bank, 2005); however, the largest sectors in the country were services (69.5%) and industry (26.5%), while agriculture represented only 4% of the national GDP. In addition, the proportion of agriculture, forestry and fisheries in GNI decreased from 8% in 1990 to 4% in 2004 (Torres-Rojo, 2004; Presidencia de la República, 2004). In 1982 the agricultural sector entered a crisis and since the second half of the 90s that crisis has worsened. Mexican farmers receive little government support and as agriculture is further integrated in a multilateral trading system, they are increasingly exposed to competition from highly protected (subsidised) agricultural systems of developed countries (especially

[1] Purchasing Power Parity
[2] United Nations Development Program

[3] Where a value of 0 represents perfect equality, a value of 100 perfect inequality

US). This has adverse impacts on the development of the sector (Amendola, Castillo & Arturo 2002; Gómez & Schwentesius , 1999), shown in the small 1.6% annual growth (in terms of GNI) for the period 1990-2002 (Presidencia de la República, 2004; FAO, 2004).

Although agriculture accounted for only 4% of GDP in 2004, it accounted for over 16% of national employment. There are signs that farmers are moving to off-farm employment, a situation accentuated by the poor availability of credit as many private banks view agricultural lending, particularly to smaller producers, as too risky (USDS, 2005); hence the strong immigration of rural populations to major cities or other countries. As a result, remittances or contributions made by Mexicans living abroad legally or illegally (mostly in the United States) have become a substantial and growing part of the economy, $18 billion in 2005 (Ratha, Shaw & Dadush, 2006); one of Mexico's biggest sources of foreign income, together with oil, tourism and foreign investment (Gazcon, 2006).

Table 1.4 Major economic groups in GDP over the years 2000-2004 (Banco de Mexico, 2004; World Bank, 2005).

National accounts	2000	2001	2002	2003	2004
GDP *(billion US$)*	581.43	622.09	649.08	639.08	676.50
GDP growth *(annual %)*	6.60	- 0.16	0.83	1.41	4.36
GNI per capita *(US$)*	5,110	5,560	5,960	6,290	6,790
GNI *(billion US$)*	501.06	552.51	600.60	643.53	704.91
Agriculture, *value added (% of GDP)*	4.17	4.15	3.94	3.89	4.07
Industry, *value added (% of GDP)*	28.02	27.26	26.48	25.79	26.44
Services, etc., *value added (% of GDP)*	67.81	68.59	69.57	70.32	69.49

1.1.6 The role of the fisheries sector in Mexico

In production, Mexico is among the first 20 countries globally at 1.5 million t a year (average for 2001 and 2002), representing 1.5% of global catch; of which 65% was used for direct human consumption, 32% for indirect human consumption[4], and the remaining 3% for industrial purposes[5] (CONAPESCA, 2003; SAGARPA, 2004a). Aquaculture contributed 12.5% of this total.

A great part of the national catch is based on a few large stocks, i.e. small pelagic fish (sardines, mackerels, etc.); and big pelagic (e.g. tuna), representing around 50% of output; in addition to squid and shrimp, at around 14%. Tilapia (also known as mojarra) and carp are the main fresh water species, at 4% and 2% of output respectively. As shown in Figure 1.7, unlike other species, tunas, tilapia and oyster output has either decreased or remained relatively static. Nevertheless, apart from shrimp[6], all major fisheries still have growth potential if management / overexploitation are properly addressed (CIBNOR, 2006).

The current declining trend of those fisheries is mainly due to overexploitation, poor management, an increase of fishing effort and lack of surveillance. In the case of tilapia, they have arisen from naturally occurring changes in reservoirs and the poor quality of broodstock and fingerlings, produced at government fish culture centres, resulting in smaller fish size and hybridization (FAO, 2003b). Since 1981 three main declines in total production have also been registered (1983, 1993, and 1998), due to the effects of “El Niño and La Niña”, mainly affecting major species such as sardines and tunids (NOAA, 2005;

[4] Fish meal and fish oil

[5] Non-edible species, products or sub-products mainly designated to be transformed and processed by the chemical-pharmaceutical and craftsmanship industry.

[6] Due to over fishing

Retamales, 2002). If widespread overexploitation persists, the contribution of fisheries to the Mexican economy can be expected to diminish with time (FAO, 2003b).

Of the national fisheries output, 77% came from the Pacific Coast, 21% from the Gulf of Mexico and only 2% from inland water bodies (CONAPESCA, 2003; SAGARPA, 2004a). More than two-thirds of production comes from four states: Sonora (34%), Sinaloa (16%), Baja California Sur (11%) and Baja California (9%) (CONAPESCA, 2003; CIBNOR, 2006). Veracruz is the only Gulf of Mexico state to stand out in fishery production (almost 8%). In relation to value, the picture is slightly different, where 50% came from 3 states, Sinaloa (23%), Sonora (18%) and Veracruz (9%), due to production of higher value species (e.g. crustaceans, molluscs and fish scale).

Regardless of the concentration of industrial fisheries, less than 40% of Mexican fishermen are found within the Pacific Coast, another 40% in the Gulf of Mexico and 8% in inland states. Most fishing communities are small to mid-size and devoted to artisanal fisheries. Many of the smallest still lack such commodities as electricity and running water. Immigration is an important component of population growth in these communities and areas (Alcalá, 1986). Activities related to fisheries, such as ice plants and the sale and maintenance of outboard engines and fishing gear may also comprise a sizable part of the local economy. In inland communities however, fishing is usually a secondary activity, except for those near the biggest reservoirs (FAO, 2003b).

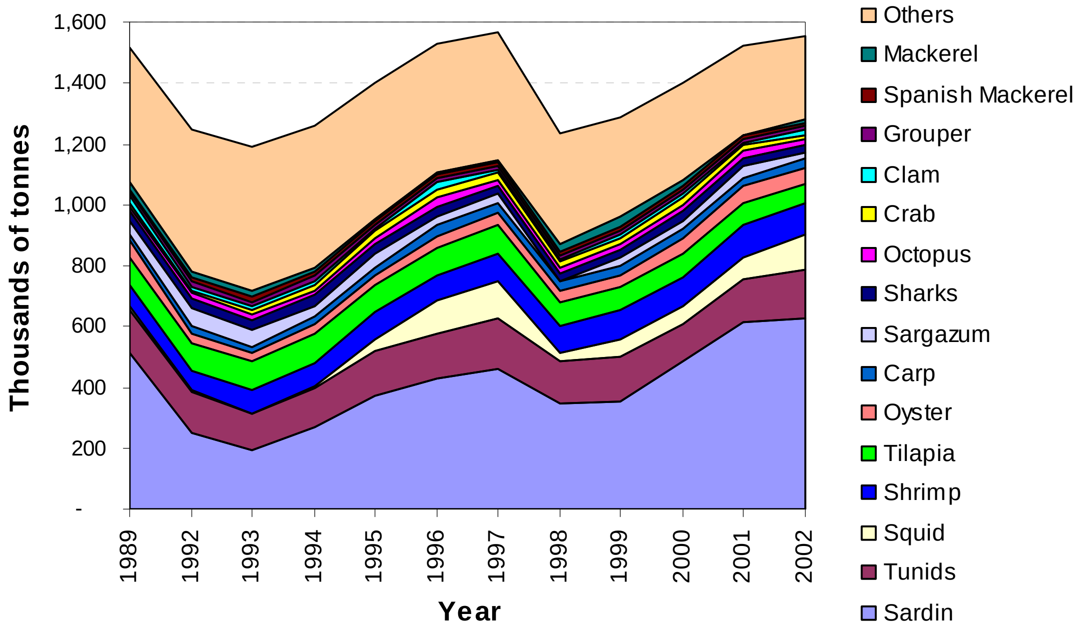

Figure 1.7 Main species produced by the Mexican fishery sector (CONAPESCA, 2003).

Demand for fisheries products, all else being equal, should rise with population and economic growth (1.8% per year). However, this has not been the case. Meat (including red meat, poultry and fish and shellfish) consumption in Mexico rose from nearly 3 million t in 1990 to around 5.5 million in 1999, whereas fish and shellfish alone (31.5% of that figure in 1990) dropped to 18.1% by 1998 (Lastra *et al*., 2000). A sizable proportion of fresh fish products is consumed locally. Processed products are widely distributed, although due to inadequacies restrictions and ability to deliver good quality, frozen products are restricted to places with proper facilities. Mexico City remains an important market and distribution hub. A long chain of middlemen characterize the distribution system although reliable data on its structure are lacking (FAO, 2003b).

According to CONAPESCA (2003) fishing exports reached almost 204,000 t in 2001. Mexico's main customer was the United States, with 59% of the total export volume, but 85% of total value (as frozen shrimp comprises 30% of Mexican exports to the US). In terms of volume, other important customers are South Korea (10%), Japan (5%), Spain

(6%) and Taiwan (0.5%). Frozen shrimp has become the most important product (19% of volume, 66% of value); although greater in volume (28%) frozen fish is only 5% of total value. Imports (by volume) come mainly from the United States (34%), Chile (15%), Canada (2.6%) and Spain (1.5%). A sizable portion (27%) of the 136,000 t imported in 2001 was frozen or fresh fish. Fish oils comprise another 18% and canned fish 12%.

Despite the small contribution from the sector to the national economy, at only 0.8% of the GDP (US$1.3 billion) and employing around 1.3% of the working population (268,727 people, including aquaculture), growth rates of the sector were 5.5% and 3% in 2001 and 2002, both higher than the economy as a whole. Mexico has traditionally maintained a surplus in its trade in fishery products, bringing foreign exchange earnings. In 2002, the figure stood at around US$379 million, with exports worth US$594 million (less than a fifth of the national catches and more than half the value of Mexican fisheries products) and imports worth US$214 million (CONAPESCA, 2003). If fishermen’s families and people employed in fisheries-related jobs were added (processing, trade, retail, management and diverse services), more than a million people depend on the sector. (FAO, 2003b; OECD, 2002, 2006; SAGARPA, 2004a). Representing a key factor for the economic development of rural areas, where often alternative opportunities are limited.

1.1.7 Potential of tilapia farming

Tilapia

Ross (2000) highlighted the attributes of tilapia and the reasons for its success as a species. This is largely due to their robustness, tolerance, flexibility and overall plasticity. This plasticity is evident from their diversification and radiation into available niches, and characterized by a remarkable physiological hardiness, adaptability and general levels of tolerance to most potentially limiting environmental variables. Many tilapia are euryhaline and can be cultured in fresh, brackish or salt water. While they are not cold tolerant, they are eurythermal over a wide range, and this only limits their distribution to tropical, sub-tropical and warm temperate climates. They also have a good tolerance of low dissolved oxygen (DO) and are quite resistant to reasonable physical handling (Morales, 1991; Popma and Masser, 1999; Ross, 2000; Watanabe et al., 2002). Most tilapias are omnivorous with a preference for soft aquatic vegetation and detritus (Beveridge and Baird, 2000). In consequence of their large size, good flavour, and rapid growth rate, many tilapias are at the focus of major fishing and aquaculture efforts.

Global outputs

World tilapia production has boomed during the last decade, output increasing three fold, from 830,000 t in 1990 to more than 2.5 million t in 2004. This is widely distributed; with production in over 100 countries in 2002 (Alceste and Jory, 2002; Fitzsimmons, 2003b). Asia is the major contributor with almost 61% in 2004 (Figure 1.8), Africa 30% and the remainder mostly from C. and N. America (5.1%) and S. America (4.5%). Almost half of output comes from only two countries, China (excluding Taiwan) and Egypt, at 35% (897,276 t) and 13% (339,599 t) respectively. Other major producing countries are Philippines (7%), Indonesia (6.2%), Uganda (5.5%), Thailand (4.8%), Brazil (3.6%), Taiwan (3.5%), Mexico (2.5%) and Tanzania (2.3%). The strong increase in global production has mostly been driven by China's dramatic increase from 106,000 t in 1990 to almost 900,000 t in 2004 (FIGIS, 2006).

During the last half century fish farmers throughout the tropical and semi-tropical world have begun farming tilapia. Almost 72% of the production in 2004 (1.8 million t) was produced through aquaculture (Josupeit, 2001), with all commercially important tilapia belonging to the genus *Oreochromis.* More than 90% of all commercially farmed tilapia are Nile tilapia (*O. niloticus*). Less commonly farmed species are Blue tilapia (*O. aureus*), Mozambique tilapia (*O. Mossambicus*) and the Zanzibar tilapia (*O. urolepis hornorum*) (Morales-Diaz, 1991; Popma, 1999; Castillo-Campo, 2003).

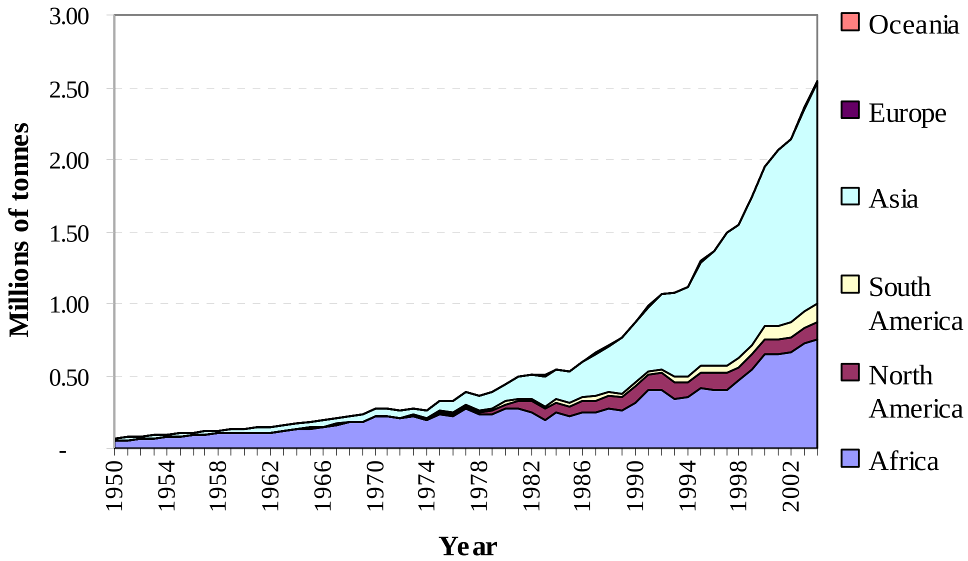

Figure 1.8 **Global production of tilapia and other cichlids (inland water bodies only) by continent over the years 1950–2004 (FIDI, 2000; FIGIS, 2006).**

Global Markets

International trade of tilapia is limited but growing, with an estimated 100,000 t in 2004 (Josupeit, 2004), growing in importance only in the last decade. The US remains the main market, though with expanding imports to Europe, particularly UK, Germany, France, Belgium, Italy and the Netherlands (FAO, 2001). Main trading flows are between Central America (Costa Rica, Ecuador and Colombia) and the USA, and between Asian producers (China and Taiwan PC, Indonesia, Vietnam and Thailand) and the USA and Japan. There is also a modest trade between Jamaica and the UK. The biggest exporter, Taiwan PC, supplies Japan with high quality tilapia fillets for the sashimi market and ships frozen tilapia to the American market (Fitzsimmons, 2003b). Taiwan exports about 35% of its domestic tilapia production and supplies 80% of the US tilapia imports (NMFS, 2005). Thus, supply is primarily from China, Southeast Asia, Ecuador and Central America; whereas demand is mainly in producing countries, USA, Japan and increasingly the EU. Table 1.5 shows the major tilapia market segments in the US and EU, highlighting the emergence of new players (i.e. Zimbabwe) and trade dynamics (i.e. intra EU production and trade).

Table 1.5 Major tilapia market segments in US and EU (Fitzsimmons, 2003b).

	Suppliers	
Segment	**To USA Market**	**To EU Market**
Live fish	US growers	EU growers
Fresh fillets	Ecuador, Honduras, Costa Rica and Panama	Jamaica, Ecuador, and Zimbabwe
Frozen fillets	China, Indonesia	China, Indonesia
Sashimi grades	Taiwan	Taiwan

Tilapia is used in many cuisines (including national dishes), in hundreds of recipes, popular in many forms (live, whole, fillet, fresh, frozen, smoked, sashimi, fried skins, etc.) and often replaces over-fished local species (Fitzsimmon, 2003b). Because of its dynamic expansion, strong marketing efforts, and increasing popularity, farmed tilapia is fast becoming a significant substitute for traditional whitefish species in many countries (Alceste and Jory, 2002).

1.1.8 Tilapia farming in Mexico

The different types of systems and technology employed for producing tilapia in various countries has been described in several occasions (Alceste, 2000; Ariyaratne, 2004; Castillo-Campo, 2003; Fitzsimmons, 2000a, 2003a, 2004; Fitzsimmons and Gonzales 2005b; Guerrero and Guerrero, 2004; Hazell, 2004; Kubitza, 2004; Martinez-Cordero et al., 2004a; Milstein and Lev, 2004; Qiuming and Yi, 2004; Rackocy et al., 2004; Szathmari et al., 2004; Tayamen, 2004; and Toguyeni, 2004). Similarly, tilapia aquaculture in Mexico has been described previously by many people (Alvarez-Torres et al., 1999, 2003; Castañeda-Castillo, 2003; Fitzsimmons, 2000a; Hernandez and Noriega, 1991; Hernandez-Rodriguez et al., 2001; Morales-Diaz, 1991; Pullin et al., 1997; Ramirez and Sanchez, 1997), in general agreeing and highlighting the great potential that Mexico has to become a major producer of farmed tilapia, especially when considering its geography, climate, hydrology and domestic market conditions, together with the availability of up-to date technology, skilled staff and cheap labour.

Production

During the 1990s Mexico became one of the world's major producers and consumers of tilapia (Fitzsimmons, 2000a). Figure 1.9 shows how from 1972, with the first registered official data (Morales-Diaz, 1991), production climbed to its maximum of 94,279 t in 1996. However, it has since declined by an average of 4% annually, reaching 67,180 t in 2003 (almost 30% less). In addition, government statistics include tilapia within the generic name of "mojarra", together with other fresh water (mainly endemic species) and marine mojarra-like species; i.e. tenguayaca (*Petenia splendida*), casta rica (*Cichlasoma urophthalmus*), mojarra marina (*Diapterus rhombeus*), etc. Participation of these species in the mojarra total production for the last two decades was less than 5% (CONAPESCA, 2003).

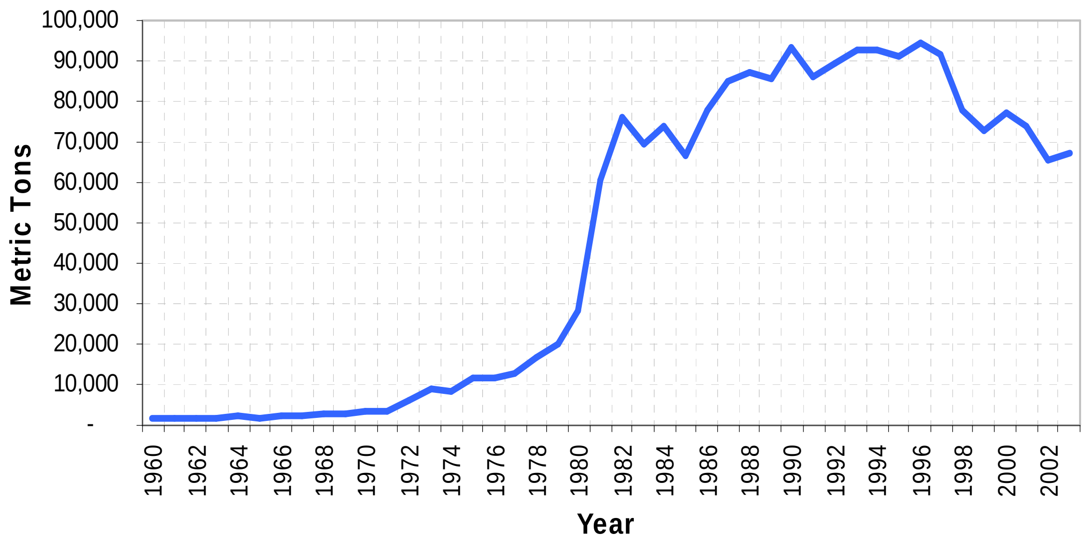

Figure 1.9 History of Mexico's total production of "mojarra"[7], including fisheries and aquaculture outputs (in tonnes per year of live weight) between 1960 and 2003 (CONAPESCA, 2003).

Almost 93% (61,516 t) of production in 2003 came from what the government defines as aquaculture. However, most output (90.1% or 60,551 t) derived from fingerlings released into reservoirs in what are described as "aquacultural–fisheries", while "controlled systems" (aquaculture) represented only 1.4% (964 t) and fisheries 8.4% (5,664 t) (CONAPESCA, 2003). The decline in tilapia production is mostly due to reduced catching sector outputs, but aquaculture also declined. *O. mossambicus* are no longer the major culture species. *O. aureus* are the most common in the south and in reservoir fisheries, whereas *O. niloticus* and red strains are the most widely cultured in intensive operations all over the country (Fitzsimmons, 2000a).

Tilapia market in Mexico

Mexico is a large consumer of tilapia, and apart from its substantial domestic production, has been increasingly supplied externally. In 2003 imported tilapia products accounted for 7.3% (5,307 t) of national consumption (Figure 1.10). While total supply decreased by 22.4% between 1990 and 2003, mainly due to declining fisheries and aquaculture outputs (dropping 27.6% and 50.8% respectively), imported supply rose from virtually nothing in 1990. Fisheries outputs are likely to remain similar if not continuing to decline for the coming years, as they appear to have reached maximum levels and most fisheries management issues could be difficult to address due to the complexity of the industry.

[7] Represented mainly by tilapia (*Oreochromis sp.*) and in a lesser extend by other freshwater cichlids and marine species.

Aquaculture and imports are however, expected to rise due to the increasing interest of governmental and private sectors on the former, and increased demand by major traders for the latter.

There are highly developed internal markets for tilapia products in Mexico and little is exported. Fitzsimmons (2000a) described three main types of domestic market in Mexico, subsistence, local fresh market and live market. Fish are marketed most commonly fresh on ice form throughout the country. Prices can vary considerably during the year and in different locations. Quality also has a major impact on price. Size, presence of off-flavour and degree of freshness are key determining factors.

According to NMFS (2005), Mexico exported small amounts (< 20 t yr^{-1}) of tilapia products (mostly fresh fillet) to the USA from 1993 to 1999. Since then there has been no reports of more exports to this country or any other. Contrasting with the rapid growth in exports of tilapia products from neighbouring countries (e.g. Ecuador, Costa Rica) to the US market, and the important income generated.

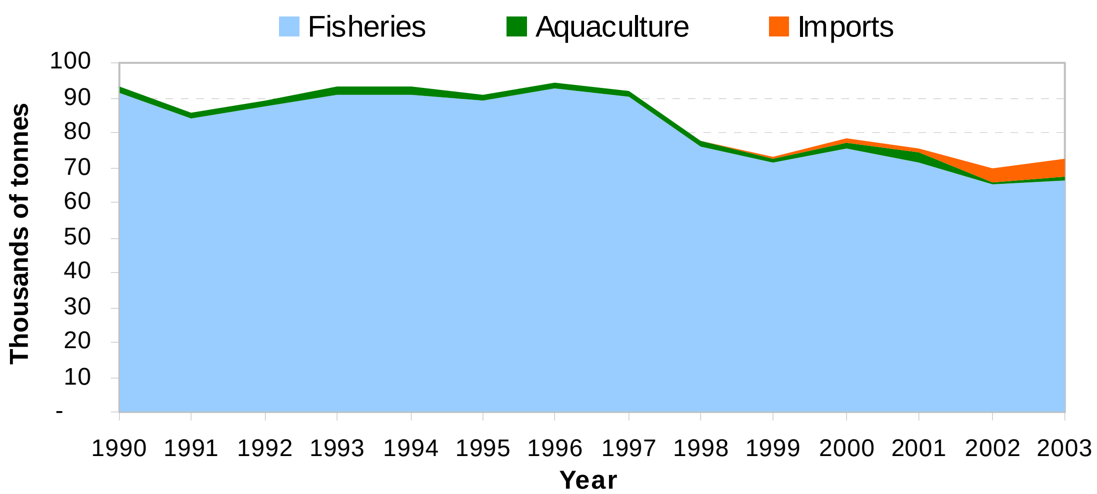

Figure 1.10 Supply of tilapia products (in tonnes of live weight product) to the Mexican market between 1990 and 2003 by major sources (CONAPESCA, 2003; NMFS, 2005).

Constraints of tilapia farming

Despite the great potential of tilapia farming in Mexico, successful commercial culture faces a number of problems. Major constrains include:

Poor availability and quality of seed

Governmental hatcheries have produced free fingerlings for many years as part of social programs targeting inland fisheries and subsistence aquaculture (Morales, 1991). This situation has prevented the development of private hatcheries, and the development of a competitive industry, including proper genetic and reproduction techniques. Production of tilapia seed represents a major issue among farmers, where proper and up-dated technology is in the hands of only a few producers. This situation becomes especially important when considering the long distances within the country and the isolation of some producers.

Feeding

Most tilapia aquaculture in Mexico utilizes prepared feeds. In the south and in areas that use extensive culture methods, simple feeds are prepared by hand or on meat grinders from locally available materials. In the more industrialised north and urbanized areas of central Mexico, manufactured feeds are more common (Fitzsimmons, 2000a). Feed is a major part of production costs, especially in intensive systems (Engle, 1997b; Muir et al., 2000). Most feeds are formulated to meet standard nutritional requirements, not specifically “fine-tuned” for individual system regimes.

Disease

Diseases appear to be only a minor constraint to tilapia producers in Mexico. The most common health problem is infestation with parasites, common to most warm water fish and these cause mortalities and reduced growth (Jimenez-Guzman, 1996). However, major bacterial problems that have become a significant factor in tilapia aquaculture around the globe are *Streptococcus*, *Mycobacterium, Aeromona, Pseudomonas, Vibrio, Edwardsiella* and *Pasteurella*, with the former as the most serious pathogen for intensive cultures (Baya, 1996; Bunch et al., 1997; Crosby, 1996; Evans et al., 2006; Fitzsimmons, 2000a; Muir *et al.*, 2000; Plumb, 1997; Stickney, 2000). Most common bacterial diseases reported in Mexico are *Aeromonas, Streptococcus, Mycobacterium, Vibrio* and *Pseudomonas*, (Conroy and Armas, 1997; Garcia-Marquez, 1996; Merino-Contreras et al., 2006; Morales-Diaz, 1991).

Gnathostomiasis is an important food-borne parasitic zoonosis endemic mainly where people prefer to eat raw freshwater fish. In N. America, the first recorded case of gnathostomiasis was in Mexico in 1970, and the numbers of gnathostomiasis patients in Mexico seems to be increasing dramatically with time (Ogata et al., 1998). This parasite rather than been linked to output decline has greater health and marketing concerns for the industry.

Marketing issues

The domestic market for tilapia in Mexico is characterised by strong supply from the catching sector, increasing supply from imports and incipient supply from an undeveloped aquaculture industry, largely dominated by small operations.

Although domestic demand is still larger than production (Monroy, 2003), a major challenge is the ability to compete with more widely available products from other, potentially lower cost production systems (Muir et al., 2000). Especially if markets drive towards unified product forms with low producer profit margins, opportunities for smaller scale producers would diminish, particularly if biotechnology gains are preferentially available to agro-industrial producers (Young et al., 2000).

According to Young et al., (2000), "growth in tilapia production has tended to be driven by production aims and technical progress rather than by proactivity to the needs of the market, as in many other fisheries. With notable exceptions, simple but fundamental market issues such as reaction to shape and skin colour, the presence of bones, potential as a gourmet dish, and other attributes, have tended to take secondary importance to technical solutions and production price driven strategies. This is not altogether surprising since the imbalance of market power, size of producers relative to markets, distance, and the intricacies of diverse market segments make it problematic to gather market data and understand diverse buyer behaviour. Nevertheless, if tilapia is to compete effectively it will be vital to promote a stronger marketing orientation". As Swanson (1995) said, "in order to be competitive, growers most focus on what the market wants, not on what they can grow".

Economic issues

The large majority of producers in Mexico are small scale, a situation placing them at a disadvantage to compete with larger and cheaper sources, i.e. the catching sector or imports. Common for all major aquaculture species, increased availability may result in reduced prices, to the extent that producers face unprofitability, and may merge or leave the market, reducing the propensity to further investment (Young et al., 1994).

According to Fitzsimmons (2003), at around US$1 kg^{-1}, Mexico has one of the highest production costs worldwide, 40% higher than in China, the major supplier of products to US and Mexico; and 100% higher than product from the catching sector. Most costs are associated with feed, electricity, water and labour, with the former as the main cost on most farms (Engle, 1997a; Muir *et al.*, 2000; Young *et al.*, 2000).

1.2 Objectives of the Study

The primary aim is to explore whether the apparent failure of the tilapia aquaculture sector in Mexico can be understood and corrected. In broad terms, domestic demands are good and the immediate neighbour, the USA, has a wealthy and strongly growing market for tilapia. Good production conditions are potentially available in Mexico, and there technical skills and support resources.

Successful development of aquaculture not only requires appropriate natural environmental conditions and the availability of workable technical methods, but also receptive and supportive social and economic conditions. On the economic side, needs, markets, availability of suitable resources and appropriate systems of property rights are seen as important. Significant social influences are security of property, social mechanisms used for resources allocation and determination of resources use, the legal system, the political system, tastes, and social values (Tisdell, 1994). Even if biological, technological and environmental conditions are favourable for aquaculture, it may fail if social and economic factors are unfavourable (Ahmed, 2001).

The objectives of this study are to gain insights and understanding of the production, trade, and business environment issues that hinder the development of the tilapia aquaculture industry in Mexico; in order to be able to make recommendations for improving the sector. The following elements are proposed:

To assess the current and potential of tilapia aquaculture production, by determining the key technological and environmental factors identified within the main producers in Mexico.

To analyse the marketing activities of tilapia farmers and their trade associations, by asserting the dimensions and rationale of the market structure, marketing channels, infrastructure and market organisation, market behaviour and physical flows, channel management and marketing strategies, product differences, the nature of competition, the concentration of market power, entry barriers and marketing operators perceptions.

To review institutional interventions, i.e. policies/regulations, support and development, financing and business organisation; that hinder or promote the development of tilapia business.

This thesis managed to provide for the first time, a wide and detailed analysis of the tilapia aquaculture industry in Mexico, identifying the key factors hindering its development in relation to production, marketing and business environment. The research found that although the country enjoys from suitable geographical and environmental conditions for tilapia culture, there were only a few operators employing adequate and up dated technology. Suggestions were made in relation to the improvement of better technology transfer schemes linking experienced producers and new entrants; the implementation of more cost-effective production methods, including the adoption of appropriate technology in relation to the availability of local resources (i.e. natural, technological and infrastructure), economies of scale and integration (vertical and horizontal); the need of closer relationship with support and development institutions (i.e. regulation, financial and research) as well as input suppliers; and more importantly, to develop products and niche markets to maximise profits.

1.3 Thesis structure

The thesis is divided into six chapters; a brief description of each is as follows:

Chapter 1: summarises the national context, as well as main issues and progresses of the country. It describes the role of the fishery sector and the potential of tilapia culture in Mexico; lead to the context and background for the present study.

Chapter 2: presents the research hypothesis and its related elements, describes research methods, selection of the study area and target groups, data collection, questionnaire design, sample size, and field work. Analytical tools are also discussed.

Chapter 3: presents results concerning current practices of tilapia farming in Mexico, including production stages, technological factors including type of systems and husbandry techniques, seed production and feeding, inputs and resources, harvesting, productions and processing, and describes the role played by tilapia farming in farmers’ income, as well as major issues and developments of the industry.

Chapter 4: presents results concerning tilapia marketing in Mexico, including product flows, supply and demand, market operators and channels, market behaviour, industry concentration, competition, prices and marketing strategies. It also describes the operators' perceptions towards tilapia trade, as well as factors hindering and promoting its development.

Chapter 5: examines and analyses the tilapia business environment, focusing on structures and systems available for its regulation, support and development, and financing, as well as gives an analysis of the actual situation of tilapia business organisations and its potential for industry development.

Chapter 6: brings together the results of the previous sections and considers the hypothesis relating to the economical potential of tilapia farming and marketing in Mexico, and also considers the business environment in which it has evolved. Finally it provides conclusions and recommendations for the development of tilapia farming and the marketing of farmed products in Mexico, based on the results from the previous chapters.

Chapter 2 Methodology

2.1 Introduction

The slow growth of the tilapia aquaculture industry in Mexico, in addition to its disadvantaged position against competing products and the lack of research, made necessary to investigate the key issues related to tilapia production, marketing and business environment for the industry development. This chapter describes the research strategy and methodology followed and explains the selection of research tools and methods for data collection. It also describes the selection of the research sites, the identification of survey targets within and associated with the tilapia aquaculture industry, the consequent sampling structure and strategy. Finally, it describes the process of negotiating to obtain commercially sensitive information and gather the necessary data, and the major tools used to analyse it.

2.2 Research hypothesis

The first stage in defining the approach of the study, having described the broad context of the research area, is to develop a primary hypothesis in relation to the key research issues, and thereby to set out the key areas of enquiry.

The key research issue of the study is to explore whether the apparent failure of the tilapia aquaculture sector in Mexico can be understood and corrected. Thus its objectives focused on gaining insights and understanding of the production, trade, and business environment issues that hinder the development of the tilapia aquaculture industry in Mexico; in order to be able to make recommendations for improving the sector. The following elements were proposed:

To assess the current and potential of tilapia aquaculture production, by determining the key technological and environmental factors identified within the main producers in Mexico.

To analyse the marketing activities of tilapia farmers and their trade associations, by asserting the dimensions and rationale of the market structure, marketing channels, infrastructure and market organisation, market behaviour and physical flows, channel management and marketing strategies, product differences, the nature of competition, the concentration of market power, entry barriers and marketing operators perceptions.

To review institutional constraints, i.e. policies/regulations, support and development, financing and business organisation; that hinder or promote the development of tilapia business.

To address these objectives involved asking the basic questions in relation to the profitability of tilapia farming in Mexico, its marketing implications and the necessary institutional tools for its development. The specific issues involved would include questions about:

How profitable and efficient is tilapia farming in Mexico compared to other competing products?

What marketing strategies are required for farmed tilapia products compete within the Mexican Market?

What is needed to improve the business environment to promote tilapia farming in Mexico?

Having defined these questions, the objective of this study is to examine the conditions under which tilapia aquaculture might develop in Mexico. To do so, a development hypothesis is set out as follows:

"Tilapia production has considerable scope for profitable expansion if competitive product quality is attained through active public/private sector development".

To specify and test this in further detail, the overall hypothesis is separated out into three main sub-hypotheses, the satisfaction of each of which would be required for the overall hypothesis to be met. These specific hypotheses are:

"Tilapia can be produced competitively and profitably in large quantities in Mexico"; this would depend not only on the employment of proper technology and husbandry techniques, but also on reducing production costs and targeting strategic markets.

"Product quality can be promoted to meet standards of key markets"; this would depend on the employment of effective processes to produce the final product at a profit and its marketing strategies.

"That public/private sector partnerships can be promoted for appropriate development"; this would depend on local conditions, sectors involved and perceived gains from doing so.

To then be tested in by a more specific enquiry for which definable methodologies were applied.

2.3 Selection of targeted groups and study area

In order to gain a clear understanding of the situation of the tilapia industry as a whole, the research considered the tilapia marketing chain (farmers – retail & foodservice outlet/ consumers) along with the business environment of the industry (e.g. institutional agents, regulatory authorities, financing groups, and economic development agents). The goal of the study was to evaluate the tilapia farming industry (including marketing operators of other tilapia products) at the national level. However, as it was impossible to cover all the businesses involved in the industry within the whole country, the research targeted those regions in which the most representative businesses of each sector were located. These areas were defined in relation to the information gathered from secondary data and the first phase of the field work.

Individuals/organisations with the most dynamic and representative role within the tilapia industry in Mexico were defined mainly in relation to their production outputs or product volume traded, experience and relevance within the sector or region (e.g. largest operations within the region, operating for a long time and with commercial aims). Figure 2.1 shows the diagram of the tilapia production and trade process, where different groups of people are involved in different activities within the industry's business environment.

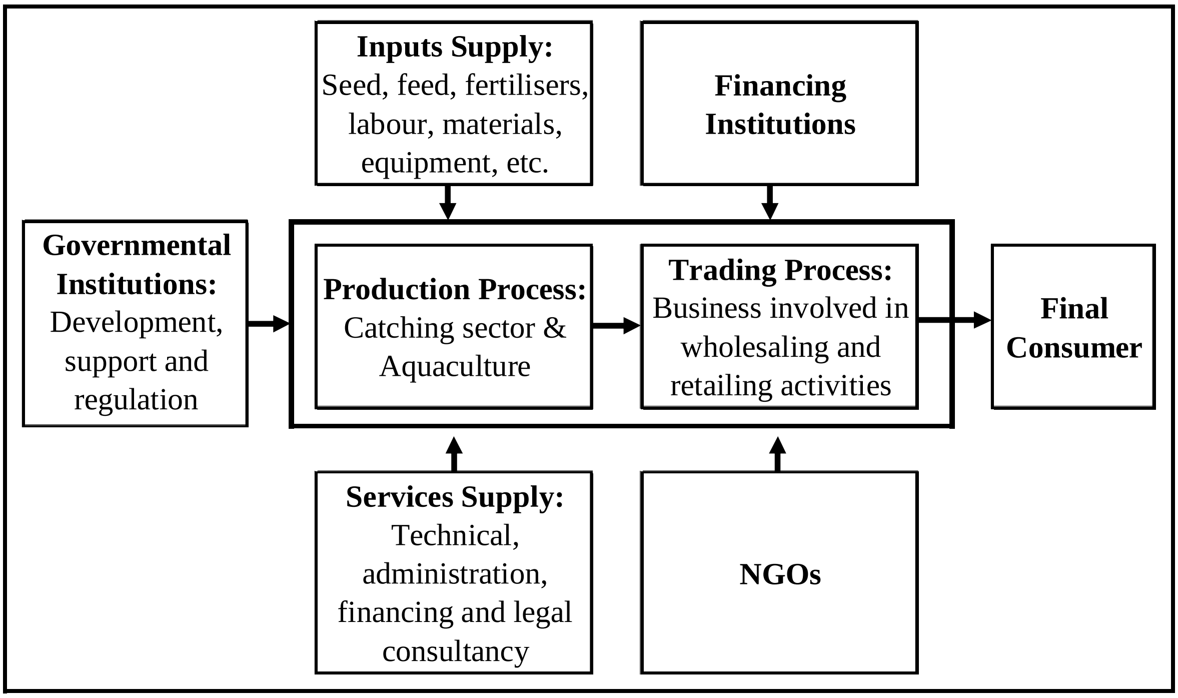

Figure 2.1 Diagram of tilapia production and trade processes (adapted from CONAPESCA, 2003; Reyes, 2004).

It was the aim of the study to understand more clearly how these groups are identified, how they interact, and what implications this has for the hypothesis stated earlier. The broad approach has been to develop estimates of the numbers of each category (cross-checking with each group), and to structure data collection to ensure that representative responses are obtained. Thus to examine the three sub-hypothesis of the study, the following groups of people were identified:

2.3.1 Farmer

As mentioned in the previous chapter, tilapia farming in Mexico is a fairly recent phenomenon (Morales, 1991; Fitzsimmons, 2000a) and remains a small sector within the national agro-industry. According to Alvarez *et al* (1999), 80% of the aquaculture in the country is extensive or of low yields. The sector is mostly represented by small producers that live in the rural areas and complement their livelihood earnings with other activities in order to supplement their family income, e.g. work as seasonal labourers or as part-time farmers or occasional wage earners.

INEGI (2005) reported 2,665 aquaculture farms registered in the country by 2003. However, there was limited information available in relation to the number and distribution of commercial aquaculture operations in Mexico producing tilapia. At the time of the study, the latest national directory of aquaculture available was published by SEMARNAP (the predecessor of SAGARPA) in 2000. Table 2.1 shows the small number of tilapia farms listed in the directory per state, contrasting with the amount of farms of other species registered. Moreover, many of these businesses producing tilapia were no longer operating at the time of the study, depicting an inaccurate distribution of tilapia farms within the country.

Table 2.1 Number of tilapia farms in relation to other species, listed in the national aquaculture directory (SEMARNAP, 2000).

State	# of Farms (incl. hatcheries) Tilapia	Other Species	Species
Jalisco	9	5	Catfish, bull frog & carp
Tabasco	9	3	Shrimp
Campeche	8	4	Snook
Veracruz	7	18	Oyster, crab, prawn, ornamental fish, trout & shrimp
San Luis Potosi	6	0	
Colima	4	4	Shrimp & Lobster
Michoacan	4	10	Trout, carp, catfish, bull frog, ornamental fish & f. w. bass
Morelos	4	19	Ornamental fish, catfish, prawn & trout
Coahuila	2	1	Cat fish
Durango	2	4	Catfish, trout & shrimp
Nuevo Leon	2	2	Catfish & snook
Tamaulipas	2	10	Shrimp & catfish
Yucatan	2	3	Shrimp & ornamental fish
Baja California	1	36	Oyster, clam, catfish, abalone, shrimp & tuna.
Hidalgo	1	7	Trout
Queretaro	1	1	Catfish
Baja California Sur	0	13	Oyster, shrimp & clam
Chiapas	0	5	Shrimp
Chihuahua	0	4	Trout
Distrito Federal (Mexico City)	0	6	Trout, shrimp & fresh water lobster
Guanajuato	0	8	Catfish, trout, carp, f. w. lobster, f. w. bass
Guerrero	0	1	Shrimp
Mexico (State)	0	7	Trout
Nayarit	0	26	Shrimp & ornamental fish
Oaxaca	0	4	Shrimp
Puebla	0	8	Trout
Quintana Roo	0	1	Ornamental fish & frog
Sinaloa	0	94	Shrimp
Sonora	0	126	Shrimp, Oyster, clam & f. w. bass
Total	**64**	**430**	

Nevertheless, some governmental institutions in a few states were able to provide up dated data of tilapia farms within their locality, i.e. Yucatan (21 farmers), Campeche (63 farms), Tabasco (303 farms), Veracruz (346 farms), Colima (15 farms), Jalisco (42 farms), Nayarit (9 farms), and Sonora (2 farms) (Integradora Maya Kay, 2004; Secretaria de Pesca del Estado de Campeche, 2003; Subdelegación de Pesca del Estado de Tabasco, 2003;

Departamento de Acuacultura del Estado de Veracruz, 2002; Subdelegación de Pesca en Colima, 2003; Instituto de Acuacultura y Pesca del Estado de Jalisco, 2003; Dirección de Pesca del Estado de Nayarit, 2004; IAES, 2003). Many of these operations belonged to the social sector and very little was reported on private businesses, normally the ones trading farmed products.

Some authors (Fitzsimmons, 2000a; Alceste, 2000 and Watanabe, 2000) however, have described a number of important farms in Mexico, mainly located within the centre and north of the country (Tamaulipas, San Luis Potosi, Jalisco, Chihuahua and Sonora), and employing more technologically advanced systems, i.e. concrete tanks, raceways, geothermal water, artificial aeration and intensive cultures. Though similar to the 2000 official directory, at the time of the study many of them were no longer operating.

Rivera-Arriaga *et al* (2001) further described as the main aquaculture coastal regions of the country the states of Sinaloa and Sonora in the northern Pacific, Campeche in the Gulf of Mexico, and Tabasco (with some low-scale efforts). Although the former mostly referred to shrimp farming, they also highlighted the potential of these regions for the culture of other tropical species like tilapia, and more prone to attract new entrepreneurs.

2.3.2 Fisherman

A practice that contributes significantly to tilapia production throughout Mexico is stocking and harvesting from reservoirs, envisioned by the government as “ranching” operations in which hatchery reared juveniles would be stocked in the water bodies and allowed to grow. This activity was defined by the Mexican government as “aquacultural-fisheries”, but for the purpose of the study, both fisheries and aquacultural-fisheries were included into the fishermen or catching sector analysis. According to Fitzsimmons (2000a), fishermen were commonly resettled families and rural communities located near by the water bodies, harvesing the fish for direct consumption or sale to local markets. The typical equipment employed was a small boat (< 10 t capacity) and gillnets (officially up to 5 gillnets per fisherman in some of the major reservoirs) (Perez-Velazquez et al., 2002; SAGARPA, 2004a).

According to Fitzsimmons (2000a), tilapia is now found in almost every state in Mexico and is established in the wild across much of the country. Nevertheless, some regions produce more than others, as shown in Figure 2.2, Veracruz and Michoacan were the major tilapia producing states in Mexico in 2003, with 17,580 and 13,758 t respectively, followed by Sinaloa, Nayarit and Tabasco with between 5,700 and 6,000 t each. Other important fisheries were located within the states of Chiapas, Campeche, Jalisco, Tamaulipas and Sonora. Appendixes 1, 2 and 3 list and describe the major rivers, lakes and reservoirs in the country, in which most of the major tilapia fisheries would be located; Figures 1.4, 1.5 and 1.6 show the geographical location of major rivers, lakes and reservoirs in the country.

2.3.3 Middleman

Middlemen were found to be specialised in trading tilapia products from the catching sector only, as farmed products were commonly higher in price, smaller outputs and inconsistent supply. The role of the middlemen was mainly to collect the tilapia from the fishermen, in some cases process the product (i.e. filleting), and deliver it to their clients, usually wholesalers. Their premises were modest, commonly including a collection point or landing area in the reservoir, vehicles for transportation (typically a 3.5 t truck with an open or closed box), and in the case of some larger middlemen, also a rustic processing plant.

Uncontrolled distribution and placement of fishing nets; many fisheries have defined breeding grounds or migration routs during breeding season where fishing is banned (SAGARPA, 2004a), however, this regulation was reportedly ignored by most of the badly managed fisheries.

Fish were normally gutted immediately after being caught and placed in plastic boxes, with the intestines thrown in to the water. As soon the fishermen finished checking all the nets, product was taken to an established collection point to be weighted and sold to traders. Fish would commonly be placed in a truck (1 or 3.5 t capacity) equipped sometimes with a thermo-insulated box, layered with ice or in bulk (see Figure 3.3).

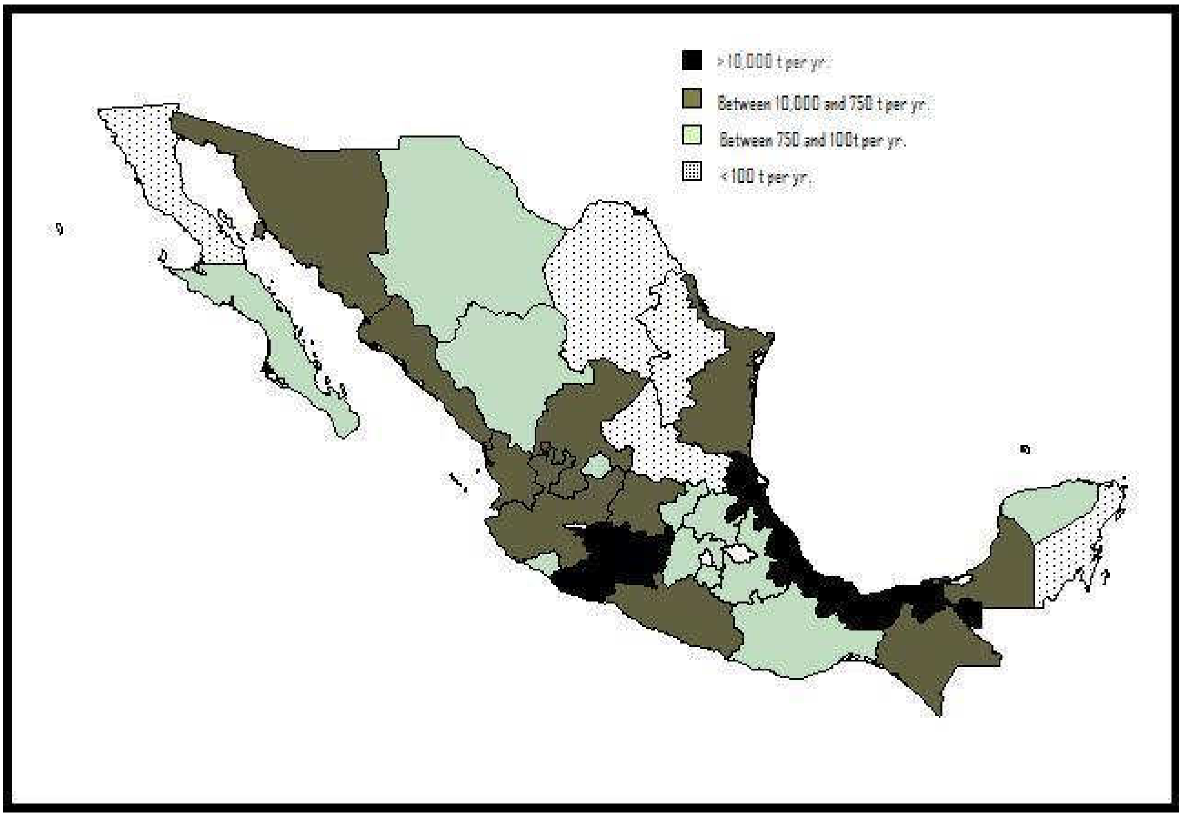

Figure 2.2 Production of tilapia in Mexico by Sates (Based on CONAPESCA, 2003).

2.3.4 Importer

The hot-spots for international trade in Mexico are located in bordering cities, major cities and large merchant ports. However, the majority of the tilapia imported entered through the USA and recently Canada (Reyes, 2003a). Thus major bordering cities in the north represented the main locale for tilapia importers. The main role of these operators was to deal with all legal and administrative procedures to bring imported tilapia products into the country and supply the marketing chain.

2.3.5 Processor

INEGI (2004b) listed 346 processing plants in 2003. According to the National Fishery Registry (2001), most of the seafood processing plants in Mexico are located within the northwest coast (i.e. Baja California 38 plants, Sinaloa 34; and Sonora 33), northeast coast (i.e. Tamaulipas 19 plants), and the southeast coast (i.e. Chiapas 23 plants, Yucatan 6, Campeche 7, and Quintana Roo 6). However, none of these plants processed tilapia. At the time of the study, there were only three industrial processing plants (i.e. registered and certified) producing tilapia products: Barol (Hermosillo, Sonora), Pisimex (Tomatlan, Jalisco) and pescados de Michoacan (Patzcuaro, Michoacan), which were included in the study (J. Lara-Zumaya and J.R. Calderon-Chavez, processors, personal communication, November/December, 2003).

Although much of the farmed tilapia processed in Mexico is done by the producers and processing by hand, each year more fish are going to large scale processing plants with increasing amounts of value added products, while also adopting the Hazard Analysis at Critical Control Points (HACCP) standards (Fitzsimmons, 2000a).

2.3.6 Wholesaler

According to Sanchez (2003), tilapia wholesalers in Mexico played a vital role in the distribution of tilapia products to the rest of the marketing chain. Normally, businesses have various degrees of specialisations and trade channels, though some businesses specialise in the trade of tilapia alone (either from the catching sector or imported).

INEGI’s 2004 Economic Census listed 365 seafood wholesaling businesses, figure that included also middlemen and importers. Wholesalers were commonly found within major cities throughout the country, however, there were three major wholesaling centres in the country where most seafood products are traded from, i.e. “La Nueva Viga” (Mexico City), "Mercado del Mar" (Guagalajara) and Seafood Wholesalers in Monterrey (Sanchez, 2003). The former (La Nueva Viga) was the largest by far, with nearly 400 businesses registered in 2003 trading seafood products, of which 88 traded tilapia (Lugame Editores, 2004; Telles-Castañeda, 2003).

2.3.7 Supermarket

Data on the retail market in Mexico is scant however estimates suggest that about a third of food retail is in the hands of supermarkets, up from nearly nothing a decade ago (Reardon, 2004). By 2003 the supermarket sector accounted for roughly 30% of food retail, and 40% to 45% of all retail, including non-food in Mexico (Victorica, 2003). ANTAD (National Supermarket Association) chains have about 12% of all food retail, Wal-Mart have approximately the same; independent supermarkets have an estimated 5% among them nationwide.

Until recently, supermarkets represented a small outlet for tilapia products; however, with the arrival of frozen products, which were well processed and packed, as well as in constant supply and at low price, this sector started gaining share. There are various supermarket chains in Mexico, many of them of Mexican origin, though, only a few highlight the volume of tilapia traded. Wal-Mart, the major supermarket chain in the country, owns around 60% of the market share (total sales), followed by Soriana, Comercial Mexicana, Chedraui and others (Sanchez, 2003). As a norm, major supermarket chains would have collection centres located in major cities, which would concentrate the supply of most of the products traded (ANTAD, 2005).

Supermarkets accounted for over 2,590 major retail stores throughout Mexico, and with 42 corporations registered through ANTAD under the category of supermarkets. Total sales floor space is 10.8 million sq. feet covering 554 branches throughout Mexico (Victorica, 2003). These major chains are widely distributed along most of the country, and normally located within medium and large populations. Table 2.4 lists the major supermarket chains in Mexico and describes their distribution within the country. The study included all 8 major supermarket chains in the country.

Table 2.2 Major supermarkets in Mexico (Victorica, 2003).

Supermarket	Region	Outlets
Cifra/Wal-Mart	All major cities	206
Gigante	All major cities	188
Comercial Mexicana	All major cities	165
Soriana	Major cities in Northern/Central Mexico	87
Casa Ley	Northwestern Mexico	78
Chedraui	All major cities	47
HEB	Northeastern Mexico	22
Carrefour	All major cities	17

2.3.8 Fishmonger

Today, fishmongers represent the main retail outlet of tilapia products in Mexico (Fitzsimmons, 2000a; J. Reyes, FIRA Financer, personal communication, 10 October, 2003); with far more outlets for fresh products (according to INEGI, there were 6,558 fishmongers registered in the country in 2003) and able to reach far more regions (including villages, small towns and poor areas of major cities) than any other sector. Due to the nature of the businesses, fishmongers were widely spread all around the country, including in small populations, rural areas and poor regions within major cities. As could be expected, they tend to be more common within coastal areas. Similar to other traders, all businesses are privately owned and self funded with various degrees of specialisations, in which tilapia commonly is the main product traded.

2.3.9 Caterer

Mostly represented by seafood restaurants, caterers were widely distributed around the country, and similar to fishmongers, more commonly found within coastal areas in the centre and south of the country, where tilapia is a popular dish. Industrial caterers however, seemed to be more reluctant to employ tilapia as none were found at the time of the study; probably due to the inconsistent supply and quality (Pesados y Mariscos Alcudia, seafood wholesaler and caterer, Tabasco, Personal communication, 2004).

Restaurants also represented an important outlet for tilapia products in Mexico. According to the INEGI's 2004 economic census, there were 61,902 restaurants, 179,218 fast-food and self-service restaurants, and 1,750 caterers registered in Mexico. However, the former were the main outlet of tilapia products within the sector. Similar to fishmongers, seafood restaurants offering dishes with tilapia were more common within the centre and south of the country, in particular Veracruz, Mexico City, Guadalajara, Tabasco, Chipas, Jalisco and Oaxaca.

2.3.10 Policy maker

Policies and regulatory issues covered by the research were dealt with various institutions/organisations. Institutional matters were dealt at the federal level in particular with the Agriculture, Livestock, Rural Development, Fishery, and Food Secretary (SAGARPA) and its sub-divisions in charge of fisheries and aquaculture matters, the Fishery and Aquaculture National Commission (CONAPESCA) and National fisheries Institute (INP); and at the regional (state) level, the State Fisheries and Aquaculture Secretary.

Other institution/organisations targeted by the study were the Economic Development State Secretariat (SDE), the Environment and Natural Resources Secretary (SEMARNAT), the Social Development Secretary (SEDESOL), the Water National Commission (CNA), and the Agriculture, Livestock, and Forestry Investigation National Institute (INIFAP); which were related to the policies and regulations within the Mexican Official Norms (NOM) pertaining to fisheries, aquaculture and seafood processing and trade.

In addition, institutions involved in the monitoring, support or development of the industry were included; these being The National Institute of Statistics, Geography and Information (INEGI), the Mexican Council for the Promotion of Fishery and Aquaculture Products (COMEPESCA), the Agri-Food Health, Innocuousness and Quality National Service (SENASICA) and the Sinaloa's Aquaculture Health State Committee (CESASIN).

Most of these institutions/organisations were based in Mexico City and in some cases, the capital of each state. CONAPESCA however, was based in Mazatlan Sinaloa.

2.3.11 Financial Institution

In its last Annual Fisheries Statistics (2003), CONAPESCA made reference of two main development banks in charge of granting credits to these types of businesses; i.e. Exterior Commerce Bank (BANCOMEXT) and Trusteeship Institute in Relation to Agriculture and Fishery Fund (FIRA-FOPESCA). Additionally, other organisations linked to agri-business financing and also covered by the study were; the Rural Bank (BANRURAL), Gulf Rural Credit Bank (BANCRUGO), National Financer (NAFIN), Shared Risk Trusteeship (FIRCO); as well as other major commercial banks like Banamex and Bancomer.

Similar to policy makers, most of these institutions were based in Mexico City, though local branches within major production and trading areas were also included.

2.3.12 Other businesses related to the industry

Other sectors that were considered in the study due to the influence that they have upon tilapia farming and its trade were:

Input suppliers; e.g. feed companies (e.g. Purina, Malta Clayton, El Pedregal, AS and Algimex), hatcheries (e.g. DAPSA and Governmental Hatcheries), and suppliers of equipment, materials, and chemicals (e.g. Aquatic Depot, Geo Bajio, Tenax, Equipesca, Pesin, Esteromar, Tenax and Distribuidora Agricola Veterinaria de Tapachula SA de CV).

Research and education institutions; e.g. ITMAR, CIAD, CISESE, CIBNOR, CESUES, UAT, INIRENA, UNAM, UV, Colegio de Postgraduados, CINVESTAV, UJAT, ECOSUR and EPOMEX.

Consultancy businesses; e.g. Genomar, The National Federation of Tilapia Producers, ASPRO, Fundaplast and “Asesores Agrupados e Ingenieria Aplicada del Tropico”.

News and Publishing businesses; e.g. Panorama Acuicola and Seafood International.

Most of these institutions and businesses were commonly found within major cities of aquaculture active areas (i.e. northwest, centre and south of the country).

2.4 Sample size

Sampling is the act, process, or technique of selecting a suitable sample, or a representative part of a population for the purpose of determining parameters or characteristics of the whole population (Mugo, 2004). Samples of the groups targeted were obtained instead of a complete enumeration (census) for many reasons, it is cheaper to observe a part rather than the whole (though careful consideration was taken to the dangers of using samples), timelines, the large size of many groups targeted, inaccessibility of some of the groups, destructiveness of the observation and accuracy (Mugo, 2004). To draw conclusions about groups from samples, inferential statistics were used, which enable to determine a population's characteristics by directly observing only a portion (or sample) of the population.

Determination of sample size should take into consideration several factors; i.e. type of research, research hypotheses, financial constraints, the importance of the results, the number of variable studies, the method of data collection, and the degree of accuracy needed (Dillon and Hardaker, 1993; Malhotra, 1999; McMillan, and Schumacher, 1989).

For this study, the sample size was defined using a mix of judgemental and snowball sampling techniques[8], as the research aimed to target those individuals with the most dynamic role (as described previously) within the tilapia industry. The approx number of institutions/businesses for each group targeted by the study and the number of individuals sampled for each group are summarised in Table 2.3. The size of the sample selected for each group targeted by the study was defined as follows:

Farmers

The regions and businesses targeted by the study were defined according to the information gathered from secondary data and cross-checked with data gathered from the first stage of the field work, which included the feedback of governmental institutions, local associations, input suppliers, NGOs and farmers. As the aim of the research was to apprise the trade of farmed tilapia products in Mexico, commercial operations were particularly targeted in the study.

Table 2.3 Number of individuals/businesses/institutions sampled in the study per marketing sector.

[8] Judgemental sampling is a form of convenience non-probability sampling technique in which the population elements are purposively selected based on the judgement of the researcher. While snowball sampling selects an initial group of respondents randomly, and subsequent respondents are selected based on referrals or information provided by the initial respondents. This process might be carried out in waves by obtaining referrals from referrals (Malhotra, 1999; McCrossan, 1984; Mugo, 2004).

Sector/Group	Population	Sample size
Farmers	801*	72**
Fishermen	196,481	24
Middlemen	n/a	10
Importers	n/a	6
Processor	346	3
Wholesalers	365	36
Supermarkets	2,590	8***
Fishmongers	6,558	35
Caterers	31,902	32
Policy Makers	n/a	28
Financing Institutions	n/a	12
Input Suppliers	507	14
Other Groups	n/a	30
Total		**310**

* Data provided only by some states and included producers from the social sector.
** 32 Hatcheries and 40 ongrowing
*** Head offices

The research covered 72 commercial farms (32 hatcheries and 40 complete-cycle or on-growing farms); were businesses with productions and trade above 1 t yr^{-1} were considered, as below that commonly resulted in operators practicing tilapia farming for subsistence purposes only with little or no trade intended. Moreover, due to the large size of the country, the study covered those operations located within the main producing regions. As an agri-business and due to the particular requirements of the species, commercial tilapia farms were normally located within rural tropical and sub-tropical regions of the country (below the tropic of Cancer) (Morales, 1991). Thus, individuals targeted by the study were mostly located within central and southern states of the country, including the states of Sinaloa, Nayarit, San Luis Potosi, Guanjuato, Tamaulipas, Jalisco, Colima, Michoacan, Veracruz, Tabasco, Chiapas, Campeche, Yucatan and Quintana Roo.

Additionally, the research also includes description of successful case studies in Mexico, highlighting their businesses organisation (integration[9], partnerships[10], and diversification[11]) and their strategies.

Fishermen

The states with the largest productions and their respective fisheries were the main target for assessment of the catching sector; which included the interview of 24 fishermen from the main fisheries / fishing associations (i.e. El Infiernillo, Temascal, Aguamilpa, La Angostura and El Salto), with trading volumes of approx 20 t yr^{-1}. Selection of individuals was cross-checked with information provided from middlemen.

Middlemen

The study focused on the most representative businesses from major fisheries (i.e. El Infiernillo, Temascal, Aguamilpa, La Angostura y El Salto), normally trading more than 100 t yr^{-1} of tilapia products. The study included 10 middlemen in the study, located mainly in nearby populations to the source (major tilapia fisheries). Individuals were selected through cross-checked information gathered from fishermen and wholesalers, as official figures were unavailable.

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[9] Can be described as horizontal and vertical integration, in the former businesses merge or acquire other business within the same level of the marketing chain (Clemente et al., 2001), whereas in the latter the firm owns all or part of its upstream suppliers and its downstream buyers (Greaver II, 1998).

[10] A partnership is the relationship existing between two or more persons who join to carry on a trade or business. Each person contributes money, property, labour, or skill, and expects to share in the profits and losses of the business (IRS, 2006).

[11] Business diversification seeks to increase profitability through greater sales volume obtained from new products and/or new markets (Hutt et al., 2003; Singh et al., 2001).

Importers

The study included 6 major importers, with trading volumes above 500 t yr^{-1}. Businesses were mostly based on major bordering cities in the north (i.e. Tijuana, Ensenada, and Reynosa), large cities (i.e. Mexico City, Guadalajara and Monterrey) and merchant ports (i.e. Mansanillo and Mazatlan) (F. Jaimes-Cantu, Importer, personal communication, 4 November, 2003). The selection of individuals depended on cross-checked information from wholesalers, supermarkets and fishmongers; as no official figures were available for this particular sector.

Processors

In contrast to the large number of seafood processing businesses available in the country, at the time of the study, there were only three industrial processing plants (i.e. registered and certified) producing tilapia products: Barol (Hermosillo, Sonora), Pisimex (Tomatlan, Jalisco) and Pescados de Michoacan (Patzcuaro, Michoacan), which were included in the research (J. Lara-Zumaya and J.R. Calderon-Chavez, processors, personal communication, November/December, 2003).

Wholesalers

Due to the large number of businesses and their wide distribution, the research focused on targeting those businesses located within major wholesaling centres (i.e. “La Nueva Viga”, Mexico City; “Mercado del Mar”, Guadalajara; and Seafood Wholesalers in Monterrey. The study covered 36 businesses wholesaling businesses, with trading volumes above 100 t yr^{-1}.

Supermarkets

Out of the 42 supermarket chains registered in Mexico, 8 highlighted for their trade in seafood products, i.e. Wal-Mart, Gigante, Comercial Mexicana, Soriana, Chedraui, Casa Ley, HEB, Carrefour (Sanchez, 2003). Commonly these corporations had collection centres (typically located in Mexico City, Guadalajara and Monterrey) were products were re-distributed to their outlets. The research targeted these collection centres due to its practicality and representative on the corporation's views on the research issues.

Fishmongers

Fishmongers were found all over the country. For effect of practicality, the research targeted 35 businesses located in major cities of regions were tilapia is most consumed, i.e. Mexico City, Guadalajara, Culiacan, Colima, Veracruz, Tabasco and Campeche (J. Reyes, FIRA Financer, personal communication, 10 October, 2003).

Caterers

Caterers were represented mainly by restaurants. Similar to fishmongers, the businesses offering tilapia were located within major cities within the centre and south of the country. Thus the study included 32 businesses located within the same areas. Individuals were selected through cross-checked information gathered from producers and wholesalers, as official figures of businesses trading tilapia products were unavailable.

Other institutions/businesses related to the tilapia industry

The study included 28 policy and regulatory institutions and 12 financing organisations. Most of these organisations/institutions were located in Mexico City or the capital of each state. The individuals targeted were located in major producing and trading regions (centre and south of the country), and selected through cross-checked information gathered from producers, traders, and other institutions.

Input suppliers and other businesses related to the industry were also targeted in the study, which included 14 businesses for the former and 30 individuals for the later. Most of these businesses/individuals were located within producing areas, and selected through cross-checked information gathered from producers, traders and other businesses/institutions related to the industry.

2.5 Data collection plan

Data can be collected mainly by observation, documentary-historical methods (secondary data), and survey methods (Lin, 1976). In order to understand tilapia production, marketing and industry development issues in Mexico, secondary data regarding the development of fisheries and aquaculture sectors over recent years were collected mainly from SAGARPA, CONAPESCA, INP, INEGI, FAO and USDA.

As data and information on the status, operations and performances of the key stakeholders in tilapia marketing channels were not available, primary data were collected using a sample survey. The two prime tools for data collection in the sample survey were standardized questionnaire surveys and in-depth interviews. Surveys may be of different types, such as personal interviews, telephone interviews, mail survey, and panel or group surveys (Lin, 1976). One of the main attributes of interviewing as a research technique is the need by researchers to come into contact with respondents (face–to-face, telephone or email), to obtain access to the facts and opinion and to receive them directly. This technique of data collection is particularly useful in gathering data on issues such as past experience and motives, which is not possible using contemporary observation (Snow *et al.*, 1994).

The standardised questionnaires were designed for the farmers and traders. Each set of questionnaires contained close and open-ended questions to be completed by the interviewee in a face-to-face fashion (if not possible, by phone, mail or email), and obtain information from the respondents on the characteristics of the surveyed organisations, the operations and performances and problems they may encounter. The in-depth interviews were conducted using unstructured open-ended questions. The analysis of these surveys is presented in chapters 3, 4 and 5.

2.6 Survey design

Due to the nature of the research, the survey design was based on exploratory and descriptive methods as suggested by Ackroyd and Hughes (1981), Bradburn et al. (2004), Maccoby and Maccoby (1976), Malhotra (1999), McCrossan (1984), StatPac (2005), and Walonick (2004). The former employed as the front end of the total research design due to its flexibility and versatility to adapt to the varying conditions of the research issues, and to discover the ideas and insights related to the main problems hindering the development of the tilapia aquaculture industry, with special focus on its production, market and business environment issues. The later, employed pre-planned, structured and semi-structured questionnaires to obtain quantitative and qualitative primary data, addressing the more specific research questions related to the tilapia marketing operators (including producers).

The data collection process and questionnaires had some degree of standardisation so data obtained were consistent and comparable between the different research areas and facilitate its analysis in a uniform and coherent manner. Although the versatility of questionnaires allowed the collection of both subjective and objective data through the use of open or closed format questions (Akcroyd et al., 1981; Bradburn et al., 2004; College of Computing, 2005; Walonick, 2004).

Therefore, the study employed semi-structured interview schedules for the personal interviews, with a multiple cross-sectional design[12] as the primary method of collecting data from different groups. The advantages of employing semi-structured interview schedules with both close and open-ended questions as the primary method of collecting

[12] In multiple cross-sectional designs, there are two or more samples of respondents, and information from each sample is obtained only once. Often, information from different samples is obtained at different times (Malhotra, 1999; McCrossan, 1984; StatPac, 2005)

data from different groups according to various authors (Duhaime and Grant, 1994; Kelmer and Noy, 1990; Kholo, 1991; Malhotra, 1999; Mintzberg, 1994; Newman, 1994; Snow d Thomas, 1994) are described in Table 2.3.

Personal interviewing however has some limitations, of which researcher and interviewee biases are considered to be the most serious (Duhaime et al., 1994). The technique of standardising interviews across sample groups, as suggested by these authors, was used to minimise the researcher bias in the study. The interviewee bias was at least partially controlled by questions posed as probes during the interview. Cross-check questions were also incorporated in the interview schedule. In many instances, it was necessary to take supplementary notes for responses, to gain better qualitative understanding of the main issues of the research.

Table 2.4 Advantages of employing semi-structured interviews.

Advantages:
- Experts' opinions were being sought. - More structured approaches were less suitable. - Qualitative and quantitative data were required. - It was inappropriate to use mail or telephone surveys due to practical and cultural constraints. - Suitable for the use of open-ended questions and visual aids. - Have the highest response rates and permit the use of long questionnaires. - Face-to-face interviews is more appropriate for research in developing countries. - Allows the clarification of the interpretation of the terms used. - Open-ended questions are effective in developing and exploring issues which might not have been apparent in initial stages. - Open-ended questions give opportunity to triangulate and confirm other views/sources.

2.6.1 Questionnaire design

A study of methods used in previous studies on seafood trade and tilapia farming was conducted before setting the questions on the interview schedule (Ahmed, 2001; Hernandez-Mogica, 2002; Lem et al., 2004). However, some modifications of questions and phrases were carried out after the first phase visit and pre-testing of the interview schedule, normally done in the course of the pilot survey.

The study comprised mainly of two semi-structured interview schedules, one for the producers (i.e. farmers and fishermen) and one for marketing operators (i.e. middlemen, importer, wholesaler, processor, supermarket, fishmongers and restaurants); and unstructured and open-ended interviews for policy makers (i.e. regulatory and development institutions) and businesses related to the industry (i.e. suppliers, consultancy, NGOs and magazines).

The interview schedule for tilapia producers was divided into three sections, which addressed the issues of the business details and production technology employed, processing and trade, support and economical issues (Appendix 4). The first section of the interview schedule was for personal information of the respondents and the business (i.e. name, location, role played within the business and experience) and the technology employed to produce tilapia (i.e. type of system employed, husbandry techniques, technology available, performance, inputs and services). The second section explored detailed information about marketing of tilapia products (i.e. post-harvest handling and processing, market targeted, distribution, marketing strategies, certification and information). While the third section related to economical issues (i.e. support and financing, regulations, economic perception and financial analysis).

The interview schedule for tilapia traders was also divided in three sections, which mainly addressed issues related to supply and sales, support, regulation and economical issues (Appendix 5). The first section focused on supply issues (i.e. source of the product, precedence, product types, prices and seasonality). The second explored detailed information about sales issues (i.e. infrastructure, volume traded, market targeted, distribution, marketing strategies, prices, competition and seasonality). Economic issues like support, financing, regulation, products traded and source of income, were focused in the third.

The other sets of questionnaires for institutions supporting, regulating and financing the tilapia industry, as well as businesses related to the industry were more simple and unstructured (Appendix 6), focusing in only in the respondent's involvement in the industry, passed activities, future trends and perception for development, with some improvised cross-checking questions when suitable.

All the questionnaires were constructed in English and then translated into Spanish to avoid confusion from the respondent, as suggested by Easterby-Smith et al., (1991), if possible written interviews should be carried out in the same language as the respondent. Closed questions were divided into questions of fact and perception, and were designed to obtain responses easily and quickly. Questions were also designed as cross-references.

2.6.2 Pre-testing of interview schedules

Pilot testing of the interview schedules was carried out by interviewing key farmers, traders, and policy makers related to tilapia, targeting included around 5 individuals for each sector. The aim of the pilot test was to ensure that the questions and issues regarding the subject of the study was included in the schedules and cleared from any ambiguities and that the respondents were able to answer the questions without significant constraint. The sophistication of the respondents, the level of enumerator, and the wording of the questions were matched (Casley *et al*., 1981). Also, it was sought to get a clearer overview of tilapia production systems, its human agents, its scale and its key relationships.

2.6.3 General Approach

Initial contact was made (by telephone, mail, or a personal visit if no other means was feasible) with companies and individuals to be interviewed in order to arrange a convenient meeting time, providing reasonable notice. The background to the study was explained, including comments to the effect that:

The study is being undertaken by DFID, University of Stirling, CONACYT and partners on behalf of the development of the tilapia industry in the country.

The content would focus on the respondent's views of production, trade, and institutional related issues to farmed tilapia products.

The interview should typically last between 30 minutes and 1 hr.

If requested, a written summary of the background to the study was sent to the interviewee by post/fax/email.

All data provided were going to be used solely for the purpose of the study and commercial confidentiality was re-assured.

Interviews started with a proper introduction and ice-breaking comments (Appendix 7), and the questionnaire used as a basis for discussions, attempting to keep the interviews as open-ended as possible when required, but also with some direct questions. The precise wording and order of the questions varied depending on the content of the preceding part of the interview and the particular interviewee.

Interviewees were encouraged at all times to provide information free of the interviewer's perceptions, and permitted (within reason) to talk freely without interruption. When interviewees raised any issues, they were expanded through further prompting. Probing was also used to encourage interesting points of discussion. Whenever possible, the interviews were recorded to leave the interviewer free to concentrate on the questions and the direction of the interview (i.e. policy makers, financers and businesses related to the industry).

Where the interviewees had doubts about a particular issue (e.g. policy makers, traders, etc.), information was presented with prompts including:

Photographs showing the production, process, and trade of farmed tilapia.

Photographs showing tilapia products characteristics.

Description of common ways to produce and trade tilapia.

Description of tilapia products and eating characteristics.

2.7 Field work

The fieldwork was based on two periods of field assessment:

2.7.1 First phase of fieldwork: scoping, study definition and initial assessment

The first part of the fieldwork was planned to last a maximum of 3 months (August - October 2003), where the study area and its zones were defined, and interview schedules were pre-tested. The study area definition was confirmed after consulting the main governmental institutions related to the aquaculture industry, i.e. CONAPESCA, the Fisheries and Aquaculture Secretary on various states, CANAIPESCA and INP; as well as other key informants including farmers, and aquaculture associations (e.g. the Veracruz aquaculture association), feed and equipment suppliers (e.g. Purina, Api-Aba, etc.), and wholesalers (La Nueva Viga in Mexico City).

The fieldwork was carried out mainly in the capital of the country (Mexico City), and the state of Veracruz (in the Gulf of Mexico). Mexico City was chosen because of the location of the main governmental institutions and traders. The state of Veracruz was chosen because it is the major producer of tilapia within the country (CONAPESCA, 2003), therefore with a well developed aquaculture industry (Alvarez-Torres et al, 1999). Data were also collected to provide an overview of the tilapia production systems, its human agents, its scale and its key relationships through primary interviews, secondary data and observation, which helped in planning the second phase of the field work. Questionnaires were also tested during the first phase of the fieldwork, as per the recommendation of Casley and Lury (1981).

2.7.2 Second phase of field work: main assessment activities

The second phase was carried out from November 2003 to August 2004. Where a more focused appraisal of the sectors and sub-sectors related to farmed tilapia products (i.e. farmers, traders and policy makers), was performed; covering the distribution and operation of tilapia farmers, the operation of the market structure, and the role of support, development and financing institutions. Key data were collected during high season for tilapia trade in Mexico (i.e. during Easter time, February - April).

2.8 Data Analysis Methods

Data and information collected were coded and incorporated into computerised databases using SPSS (Statistical Package for Social Science) and Excel software. Descriptive methods of analysis were used to describe the surveyed stakeholders in the chains, their operations and performances, using means, modes and percentages. Some diagrams were used for illustrating the farming industry situation and market operations. In addition, the concentration ratio[13] for the ten largest businesses (CR10) and the Herfindahl-Hirschman

[13] The concentration ratio (CR) of an industry is used as an indicator of the relative size of firms in relation to the industry as a whole. This may also assist in determining the market form of the industry. In general, the N-firm concentration ratio is the percentage of market output generated by the N largest firms in the industry.

Index[14] (HHI) were calculated for the analysis of the market structure, competition and concentration, to assist in determining the market composition of the industry as recommended by Young et al., (1994).

2.9 Structure of the results

Results are set out in the following three chapters, based on three sub-elements of the hypothesis, as outlined:

Chapter 3: Current situation of tilapia farming in Mexico, which addresses the sub-hypothesis of the study: “Tilapia can be produced competitively and profitably in large quantities”. This chapter describes key relationships between tilapia production and its market, taking into account inputs and technology employed. According to Jolly et al. (1993), production may be defined as the process of combining resources and forces in the creation of some valuable goods or services, and the purpose of production is to satisfy human wants and needs. This chapter addresses those issues involved in the production of tilapia to satisfy the producer’s wants and needs, focusing not only on the employment of proper technology and husbandry techniques, but also on reducing production costs and the targeting of strategic markets.

Market forms can often be classified by their concentration ratio. Listed, in ascending firm size, they are: a) Perfect competition, with a very low concentration ratio; b) Monopolistic competition, below 40% for the N-firm measurement; c) Oligopoly, above 40% for the N-firm measurement; d) Monopoly, with a near-100% N-firm measurement (QuickMBA, 2006; Wikipedia Contributors, 2006; Young et al., 1994).

[14] Herfindahl-Hirschman Index or HHI is a measure of the size of firms in relationship to the industry and an indicator of the amount of competition among them. It is defined as the sum of the squares of the market shares of each individual firm. As such, it can range from 0 to 1 (or from 0 to 10,000) moving from a very large amount of very small firms to a single monopolistic producer (QuickMBA, 2006; US Department of Justice, 1997; Wikipedia Contributors, 2006; Young et al., 1994).

Chapter 4: Tilapia marketing in Mexico, which address the sub-hypothesis “Product quality can be promoted to meet standards of key markets”. This chapter provides an in-depth analysis of the marketing conditions and structures actually present for tilapia products in Mexico, describing the supply and demand activities of the product, major marketing operators, marketing channels and product flow, and market behaviour.

Chapter 5: The tilapia industry business environment, which addresses the sub-hypothesis “That public/private sector partnerships can be promoted for appropriate development”. This chapter explored the relationship and involvement of sectors related to the development of the industry. In particular analysing the role played by support and development institutions, financial organisations, and other businesses related to the industry (i.e. research institutions, suppliers, media and NGOs). Additionally, this chapter also looked at the ways in which small and medium businesses (SMEs) could improve efficiency and competitiveness, in particular through businesses integration and associations, and economies of scale.

Therefore, next chapter (Chapter 3 Current situation of tilapia production in Mexico) presents the first part of the research results, exploring and assessing the production systems of tilapia in Mexico, main issues and trends; to be able to understand its development needs to reach profitability.

Chapter 3 Current practices of tilapia production in Mexico

3.1 Introduction

In 2003 over 2,000,000 t of tilapia were cultured worldwide, and this production has continued to expand (Fitzsimmons, 2005b). Output has grown impressively during the 1990s, and forecasts indicate it will continue to expand significantly in the years to come (Alceste et al., 2002).

Mexico produces more tilapia than any other country in the Americas (Fitzsimmons, 2000a), during the 80s and 90s Mexico's tilapia outputs were over 90,000 t per year (CONAPESCA, 2003). As a result, a whole new industry based on a freshwater species having wide impact at the national level was created for the first time (Morales, 1991). However, according to CONAPESCA (2003) aquaculture not only represented a small portion of the national outputs, but had shown little growth since tilapia was first introduced. The aim of this chapter is therefore to describe tilapia fishing and farming in Mexico and their constraints, as the study intended to provide a clear understanding and holistic approach to the research issues of the sector. It also explored the role played by tilapia aquaculture in the farmer's economic development and its marketing considerations. This description is based on published sources, together with the results of primary data collected across Mexico.

3.2 History of tilapia aquaculture in Mexico

During the 50s, Mexico saw a rapid increase of artificial reservoirs around the country, especially within the tropical areas where the major rivers are located. This allowed the government to design and plan at national level, based on fish farming, to tackle the food requirement of rural populations, creating the Rural Fish Farming Development Commission within the Mexican Navy Secretariat (Morales-Diaz, 1991), to develop a national aquaculture policy. A primary objective focused on social issues and in the development of the country's inland fisheries, aiming to develop an aquaculture plan addressing the country's main problems and needs (Table 3.1). This proposed the mass production of herbivorous and omnivorous species (in particular Chinese carps and African tilapias) through extensive aquaculture (stocking fingerlings in ranching activities). Apart from promoting food alleviation in rural areas and generate job opportunities through fishing, processing and trading, this also help to control the dissemination of aquatic plants.

Table 3.1 Main problems and needs of inland water bodies and their rural populations in Mexico (Morales-Diaz, 1991).

* Most (around 70%) of the aquatic resources (natural and artificial reservoirs) of the country are located within the tropical regions (centre coast and south of the country). * Environmental problems like the uncontrolled dissemination of aquatic plants (e.g. aquatic lily) required attention. * Food problems that required massive productions kept having priority. * Employment opportunities.

In 1964 the Department of Fisheries through the Biology and Fisheries National Research Institute (today the National Fishery Institute), through the "Papaloapan Commission", built the Temascal Aquaculture Centre in the "Miguel Aleman" reservoir in Temascal, Oaxaca (Figure 3.1). In 1967 the fingerling stocking program was extended to other reservoirs within the tropical regions of Mexico, and then to the rest of the country. Several species of tilapia were introduced in Mexico in the 1960s and 1970s. *O. mossambicus* and *O. aureus* were first introduced in 1964, *O. niloticus* and *O. urolepis hornorum* in 1978 (Pullin *et al*. 1997), and *Tilapia zillii* and at least one red hybrid sometime in between. Several additional populations of each of these species have been brought into Mexico. Introductions have been the result of privately sponsored imports as well as state and federal fisheries programs (Fitzsimmons, 2000a). Tilapia is now found in every state in Mexico and is established in the wild across much of the country.

Figure 3.1 Temascal aquaculture centre in Oaxaca, Mexico.

3.3 Current status of tilapia fisheries in Mexico

SAGARPA (2004a) described the major inland fisheries in Mexico in its "Carta Nacional Pesquera", in which tilapia was portrayed as the main output. Additional descriptions of the fisheries in Mexico have been carried out by various authors (Morales-Diaz, 1970, 1976, 1991; Bernal-Brooks, 1984; Alvarez-Torres et al., 1999; Perez-Velazquez et al., 2002), highlighting increasing problems of bad management and over-exploitation. The following sections summarise key issues and common practices of the tilapia catching sector.

3.3.1 Production

Fisheries represented 98% (75,673 t) of the tilapia national production in 2000, with 91% (70,104 t) coming from "aquacultural-fisheries[15]" and the remaining 7% (5,569 t) from

[15] Fisheries normally based on reservoirs with periodical stockings of tilapia fingerlings in ranching operations (Fitzsimmons, 2000a).

wild fisheries[16] (CONAPESCA, 2003). The ten major fisheries represented 22.6% (17,473 t) of national production of tilapia. Figure 3.2 shows the annual production and yields of these ten major fisheries in Mexico during 2000. Further information can be found in Appendix 3. Correlation of the outputs with factors such as size or volume of the water body, number and characteristics of nets employed, fingerling stockings, and close seasons, was difficult to establish, However, fisheries with the highest yields registered a fishing effort of between 2 and 0.4 nets per ha (excepting Bacurato with 12).

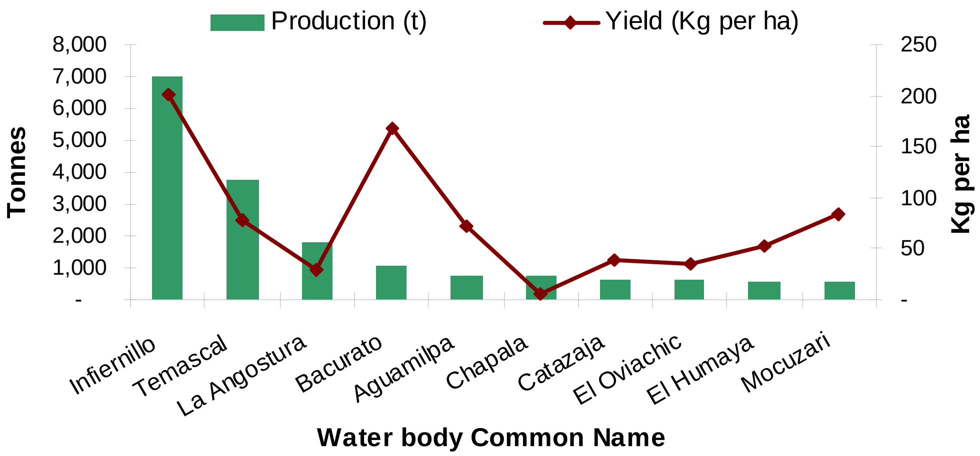

Figure 3.2 Annual production (in tonnes) and yield (in Kg ha^{-1}) of the ten major fisheries in Mexico during 2000 (SAGARPA, 2004a).

3.3.2 Fishing practice

According to Acevedo, 1998, 2001; Garcia-Calderon et al., 2002; Henderson, 1974; Hernández, 2006; Orbe and Perez-Velazquez et al., 2002; Quiros, 1995; and SAGARPA,

[16] Fisheries of wild stocks in natural water bodies (i.e. rivers, lakes and lagoons).

2004a; the main issues involved in the poor management of the inland fisheries in Mexico are:

Unsuitable fishing gear; gill nets were allowed by regulatory bodies in most fisheries. However, seine nets and cast nets were also used.

Unsustainable fishing effort; unsustainable numbers of fishermen and fishing nets employed per fisherman.

Gradual reduction of mesh size; which has become rapidly one of the major problems of the tilapia fisheries in Mexico, where an increasing number of fishermen are gradually reducing the mesh size of their nets (Alvarez-Torres et al., 1999; Perez-Velazquez et al., 2002). Sometimes as small as 2”, catching organisms with a short reproduction lifespan. Table 3.2 shows the average fish size caught by gill nets employed in tilapia fisheries in Mexico.

Table 3.2 Average weight of fish caught by fishermen according to the mesh size (Fishermen personal communication).

Mesh Size (inches)	Fish Catch Average Weight (g)
2 ½	100
3 ½	200
4	400
4 ½	600
5	800

Uncontrolled distribution and placement of fishing nets; many fisheries have defined breeding grounds or migration routs during breeding season where fishing is banned

(SAGARPA, 2004a), however, this regulation was reportedly ignored by most of the badly managed fisheries.

Fish were normally gutted immediately after being caught and placed in plastic boxes, with the intestines thrown in to the water. As soon the fishermen finished checking all the nets, product was taken to an established collection point to be weighted and sold to traders. Fish would commonly be placed in a truck (1 or 3.5 t capacity) equipped sometimes with a thermo-insulated box, layered with ice or in bulk (see Figure 3.3).

3.3.3 Fishing times, periods and quotas

Tilapia fishing times varied depending on the meeting time arranged with traders. Fishermen commonly checked their nets one to three times daily, normally between 5 to 11am. After capture the produce was placed in plastic boxes and delivered to the traders at the collection point once all the nets were checked, commonly between 8 and 11am. However, due to the increasing numbers of nets employed, the time required has considerably increased, with less time available for other activities, and exposure of the catch (i.e. the sun and 30°C) without ice for long periods (up to 6 hours) (Anon., 1990; Rojas, 1992).

Tilapia fishing periods or seasons varied greatly from one place to another. Four main types of closed seasons could be identified; during the main breeding season for tilapia, i.e. between March and May (Morales-Diaz, 1991); during the rainy season (June to September); during weekdays (Monday to Friday) all year round (e.g. Infiernillo reservoir); or two weeks-in and two weeks-out each month (e.g. El Salto reservoir).

Figure 3.3 Fishermen checking gill nets early in the morning in Chilatan reservoir (left), and one of several landing points in Infiernillo reservoir (right).

Maximum fishing effort was defined by the government for most reservoirs through establishing the maximum number of nets allowed per fisherman. However, this research found that only this was respected in only one reservoir (Aguamilpa resrvoir). Fishing quotas were set for only rarely; i.e. El Salto reservoir, allowing up to 300 kg max per fisherman.

According to the findings in the study, the highest outputs were normally obtained during the rainy season, especially during June and July; whereas lower outputs were typically registered during winter (January to March), when the tilapia tend to go deeper due to the cold weather.

3.3.4 Labour force

Tilapia fishermen were mainly male and usually fished in pairs helped by a family member or a partner. According to SAGARPA in 2000, there were a total of 244,131 fishermen registered for both marine and freshwater fisheries. The latter represented 52% (126,512 fishermen) of the total, organised in 830 associations (i.e. cooperatives and other types) distributed in 678 water bodies located in 345 municipalities within 30 states. Most (98%) of the fishing groups belonged to the social sector, and just a small number (2%) were private (SAGARPA, 2004a). Some 87% (109,386) of freshwater fishermen and 89% (739)

of their organisations registered were involved in tilapia fisheries (as either the main or complementary catch). The 10 major fisheries representing almost 30% of national tilapia fisheries production (Figure 3.2), accounted only for 10% (10,433) of registered tilapia fishermen. However, an increasing proportion of fishermen in many fisheries were reported to work informally (SAGARPA, 2004b).

3.3.5 Infrastructure

The tilapia fishery sector in Mexico is still developing, and commonly employs simple infrastructure (INP, 2000). Main components were landing points or reception centres[17] and occasional filleting plants. The number of reception centres or landing points varies, commonly dependent to the size and outputs of the water body. Only in few cases were landing points defined, located and regulated by the government. Reception centres typically consisted of a tent/tarpaulin, a weighing scale (usually a manual 100 Kg) and a table (Figures 3.3 and 3.4).

Part of the tilapia catch was filleted[18], especially in the west of the country (i.e. Infiernillo, Chapala, El Salto), normally carried out by traders prior selling to the wholesaler. Filleting plants were typically located near the fishing area and were of rustic build, using an open shelter with tables where the product was filleted manually by locals (sometimes the same fishermen) (Figure 3.4). As with landing points, the government had little or no control, and thus little information was available on the number and their conditions, with the exception of the 7 plants in Infiernillo reported by the National Institute of Fisheries (INP) (2000). There were also three industrial processing plants employing more sophisticated

[17] Where the fish is weighted and registered by the middlemen and payment to the fishermen is done either daily or weekly.

[18] Adding value to the product but requiring 3 Kg of raw product per kg of fillet produced.

techniques, two processing fisheries products (Barol in Sonora and Pescados de Michoacan) and one from farmed and imported products (Pisimex). These plants produced a wider range of added-value products, e.g. frozen fillets, nuggets, fish fingers, ceviche and deep-skinned fillets (i.e. white face fillets).

3.3.6 Inputs and consumables

The main inputs were primarily based on fishing gear and boats, fund for which were often supplied by traders. Quality and effectiveness of these varied. As most outputs came from what the government called “aquacultural-fisheries”, fingerlings were also an important input in some. However, with only a few fisheries (10) registered in the “Carta Nacional Pesquera” (CNP) (National Fishery Bill) as stocking fingerlings (SAGARPA, 2004a); it was difficult the assess the real impact on the tilapia fisheries of Mexico. The fishermen’s perception of the benefit of fingerling releases was divided, with some fisheries claiming to have benefited from it (Temascal, Infiernillo, Chilatan, El Novillo), and others asserting that sustainable production was being attained through proper fisheries management, and fingerling stocking was not required (Aguamilpa, El Salto, Huite) (Fitzsimmons, 2000a; Perez-Velazquez et al., 2002; Fishermen personal communication). Stocking varied according to the fishery, going from a single release to every year (normally spring or summer), and from a few thousands to a few millions. Fingerlings were mostly produced by governmental hatcheries around the country, mainly producing blue tilapia (*O. aureus)* and the Nile tilapia (*O. niloticus)*. Sizes were typically 1.5” in length (around 1 g), normally mixed sex (without being masculinised) (Arturo Chavez, 2003, personal communication).

According to the official figures reported in the CNP, the fisheries with higher number of nets per ha (fishing effort) in 2000 were “Los Cerros”, “Lazaro Cardenas”, “El Rodeo” and “Tejocotal” with 13.1, 2.9, 2.8 and 2.3 nets ha^{-1} respectively. However, as shown in Figure 3.5, there was no relationship between the fishing effort and the productivity of the ten major tilapia fisheries. Suggesting that proper management of the fisheries can result not only in a more sustainable option, but more cost-effective due to the lesser time and equipment required.

Figure 3.4 Traders registering the day's catch of two fishermen in a typical landing point (left), then being taken to the filleting plant to be processed (right).

3.3.7 Other constraints

Other important constraints that influenced tilapia fisheries development were:

~ The poor outcome of promotional, support and monitoring schemes from the government; with a lack of public information promoting the health benefits of consuming seafood, particularly tilapia products. Support programs were also poorly understood by fishermen and inadequately distributed. The only promotional programs from the government were focused on tuna and shrimp.

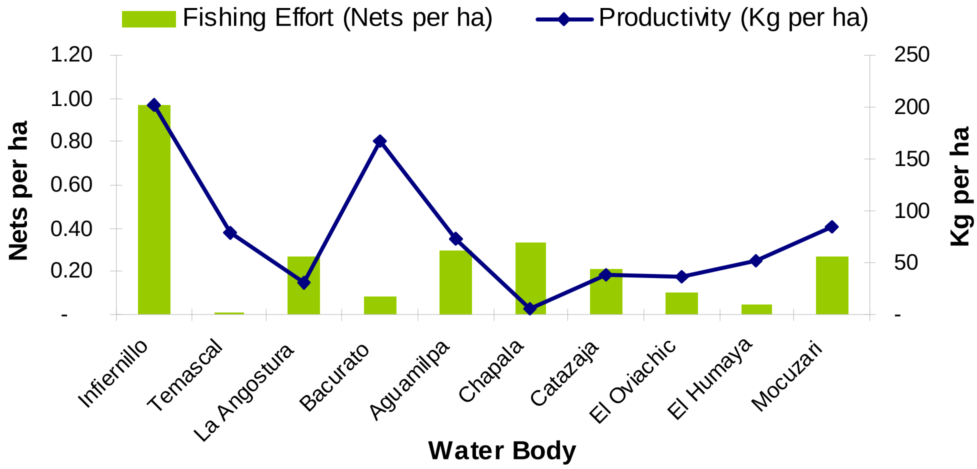

Figure 3.5 Fishing effort (nets ha $^{-1}$) and productivity (Kg ha^{-1}) for the ten major producing water bodies of tilapia in Mexico (SAGARPA, 2004a).

~ Negative public perception of seafood in Mexico, generally perceived as being expensive and risky, mainly due to poor handling. There was also a general belief of frozen products not being fresh and that seafood was high in cholesterol (Moreno, 2003).

~ Poor broodstock management in government hatcheries; commonly using old broodstock with inbreeding problems (Castañeda, 2003).

~ Poor policy recognition, partly due to definition problems as whether this activity was “aquacultural-fisheries/restocking aquaculture” (Government) or “fisheries derived from aquaculture” (FAO) with statistics and policy support under the relevant category (Moreno, 2003).

~ Pollution, eutrophication and water loss of the major reservoirs and lakes, e.g. Chapala and Patzcuaro (Anon., 1997; Bernal-Brooks, 1997; Chacon et al., 1992, 1996; Perez-Velazquez et al., 2002; SEMARNAP, 1997).

- ~ Health risks due to consumption. Human zoonoses such as gnathostomiasis, a food-borne parasite associated with eating raw fish (Ogata et al., 1998); and food-poisoning through a great array of infectious bacteria (i.e. vibrio, salmonella and coliforms).

- ~ Ecological constraints over the lack of controlled and planned introduction of tilapia to natural water bodies, competing and displacing endemic species (Morales-Diaz, 1991).

- ~ Increasing competition of imports with better presentations and low prices.

3.3.8 Future trends

According to the National Fisheries Report (SAGARPA, 2004a), the future development for tilapia fisheries is based on sustainable exploitation of resources. This would be through the development and implementation of permanent programs for monitoring, supervision and surveillance of production, fishing effort, inputs, support, close seasons and quotas.

Another important trend has been the increasing number of tilapia fishermen turning to tilapia cage farming, with greater promotion of government fingerling stocking programs (Perez-Velazquez et al., 2002).

Nevertheless, for the reasons described, fisheries outputs will most probably remain the same if not slowly declining in the short and long term. This therefore highlights the need for the development of domestic alternatives for tilapia production.

3.4 Current status of tilapia aquaculture

This section describes and assesses tilapia farming in Mexico, i.e. their distribution, technological development, marketing and business perception; to provide a clear understanding of its development, major issues and future trends.

3.4.1 Number of farms, their distribution and land usage

According to the National Institute of Statistics, Geography and Information (INEGI), 2,003 aquaculture farms were registered in Mexico by 2002. However, there were no accurate official statistics for tilapia culture as neither INEGI nor any other federal governmental institution related to fisheries (i.e. INP and CONAPESCA) had data of the amount and distribution of aquaculture farms segregated by species. However, a few state fishery departments were able to provide lists of local farms, e.g. Veracruz, Jalisco, Colima, Tabasco and Campeche; though this information was normally inaccurate and out of date.

To assess conditions more clearly, the study reviewed 72 farms, from which 32 were hatcheries and 40 complete cycle or on-growing farms. Methodologies for selection and assessment are summarised in Chapter 2. Of the farms, 31 belonged to the private sector (2 hatcheries and 29 farms), and most were located within tropical and sub-tropical regions. A quarter (25%) of farms interviewed (18 farms) were located within central and northern states, and 75% (54 farms) within the southern states; with almost 50% (19 farms) of these farms located in three southern states: Veracruz (25%), Tabasco (7.5%) and Chiapas (15%); where tilapia farming was a well known activity, probably encouraged by the local market. By contrast, hatcheries were mainly in the centre of the country (47%, 15 hatcheries), while 25% (8 hatcheries) were situated within northern states and 28% (9 hatcheries) within southern states; this is probably due to the strategic targeting of clients in both coasts of the country.

Land usage of tilapia farms was directly related to the type of system employed and the volume produced. The farms requiring larger space were farms employing ponds with a median value of 2.25 ha (ranging from 0.25 ha to 24 ha), followed by cages with a median value of 1 ha (ranging from 0.2 ha to 3 ha) and tanks with a median value 0.83 ha (ranging from 0.005 ha to 5 ha).

3.4.2 Technology employed

Production stages

Tilapia farmers commonly employed up to four main stages: hatchery, nursery, on-growing and pre-harvest. Farms had varied specialisation levels, from solely one stage of the production cycle, i.e. as commercial hatcheries or merely growing up tilapia fingerlings to market size, to covering the complete production cycle. The latter were commonly commercial private farms, while farms belonging to the social sector typically relied on fingerlings supplied from government or private hatcheries. Of the commercial farms interviewed, 55% (22 farms) produced their own fingerlings.

An important strategy noted by many authors (Brummett, 2002; Clair et al., 2002; de Graaf et al., 2005; El-Sayed, 2002; Rackocy, 1989) for tilapia culture and fish farming in general, to improve market flexibility and production efficiency is to split the culture cycle in various stages/phases (between 3 to 6), with multiple and out-of-season cropping. However, this practice was seldom found in Mexico.

Production systems

Tilapia were cultured in a variety of systems, from farms covering the complete cycle to specialised hatcheries and on-growing farms; with open to semi-closed and closed systems, using ponds, tanks and cages. The choice depended on factors including: geographical and environmental conditions, purpose (commercial or auto-consumption), sector (social or private), location and support (governmental, financial and research). The systems most commonly employed are as follows:

Hatcheries

There were two main groups, governmental aquaculture centres and private hatcheries. There were 25 major governmental hatcheries registered and 19 private hatcheries found during the research, although the latter were commonly developed as part of a complete cycle farm. State and Federal hatcheries often provided fry to individual farmers and to cooperative groups at subsidized prices. There were additional projects, often supported by missionary and religious organisations that supported small hatcheries supplying juvenile fish to “ejidos” (communal farms), social cooperatives, orphanages and church groups (Fitzsimmons, 2000a). Three major production phases were identified by various authors (Broussard et al., 1983; Ernst et al., 1991; Guerrero and Guerrero, 1984, 1985; Guerrero, 1986; Hulata, 1997; Little et al., 2000; Mair et al., 1993); reproduction, incubation and nursery (including sex-reversal); though, not all hatcheries included all of them.

Reproduction: Reproduction in government hatcheries was normally carried out in square concrete tanks and sometimes in ponds, with open water flow and sometimes with artificial aeration (Figure 3.6). Private hatcheries used tanks of various shapes (rectangular, circular and elliptical), ponds and hapa-in-ponds; most were open flow with artificial aeration.

Incubation: If applied, incubation of fertilised eggs was carried out in upwelling jar incubators with clear clean water. This was carried out mainly by private hatcheries (Figure 3.7), with only few (3) governmental hatcheries reporting its use.

Figure 3.6 Reproduction (left) and nursery (right) of tilapia in Mexican governmental hatcheries, Zacatepec (left) and Jala (right).

Figure 3.7 Tilapia incubation and nursery in a private hatchery ("La Finca"), located in the state of Veracruz, Mexico.

Sex-reversal and Nursery: Sex-reversal was carried out mostly by private hatcheries, with only three governmental hatcheries able to produce sex-reversed tilapia fingerlings (Castaneda-Castillo, 2003). Techniques employed were similar in most hatcheries, following techniques described by various authors (Shelton et al., 1981; Rothbard, et al., 1983; Carrasco et al., 1999; Little et al., 2000; Sparks et al., 2003). These hatcheries used tanks (Figures 3.6 and 3.7), ponds and/or hapa-in-ponds. Typical tanks and ponds used were square, circular or elliptical, relatively shallow (less than 1.5m deep), and made of concrete, plastic or fibreglass.

On-growing

There were two groups for tilapia on-growing, private and social sector. Figure 3.8 shows the systems most commonly used by the farmers covered in the study. 58% of the farms interviewed used tanks (33% mixed with ponds or cages), 43% used ponds (30% mixed with tanks or cages), 33% used cages (8% mixed with ponds or tanks) and only 3% used enclosures. Tilapia farmers in the social sector more commonly found to use cages, while private farms were more likely to use tanks or mixes.

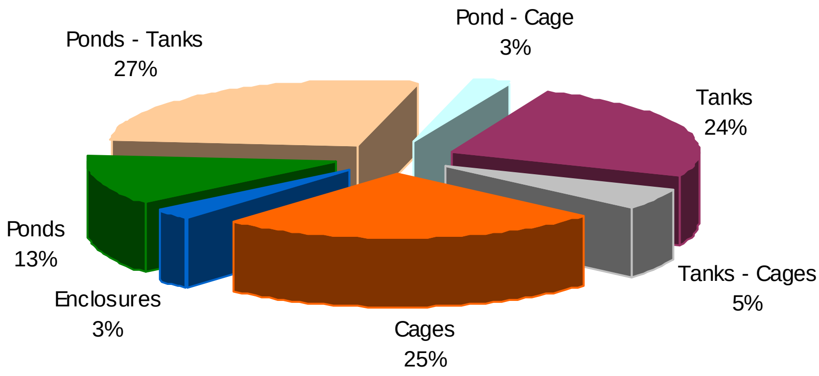

Figure 3.8 Types of production systems employed for tilapia farming in Mexico.

Pond culture: Extensive production in small ponds is still practiced widely, with fish sometimes reared only on the productivity of the pond ecosystem. In other cases the farmer fertilises the pond with organic or chemical fertilisers. Semi-intensive to intensive pond culture had become quite popular in Mexico in recent years, where aeration, feeding and sometimes prey control techniques are applied (Figure 3.9). Integral tilapia farming or the cultivation of tilapia in rice fields and in conjunction with chicken and pig production had been tested, but neither have become widespread in spite of potential benefits in efficiency and resource use (Blakely and Hrusa, 1989). However, a more common form of integration has been production of tilapia in irrigation water, where small ponds were built to store water on farm and used for tilapia production. A variation has been to rear fish in drainage water from an irrigated field. This is less appealing as the fields may leach fertilisers and pesticides that could accumulate in the fish.

Figure 3.9 Tilapia ponds; lined with aeration for intensive culture (left) and protected from predators for semi-intensive cultures (right).

Another type of small pond culture practiced in the southern state of Oaxaca is the "microcuenca", or small watershed system, a small reservoir formed when a dam was built in an eroded watershed, to control downstream flooding and capture sediments. The stored water was then used for local irrigation of grains, beans or vegetables.

Ponds used by tilapia farmers interviewed ranged from 0.02 ha to 9 ha., with a mode of 0.25 ha (20% of the farms) and a median value of 0.3 ha. Only 8% of the farms had ponds fitted with liners. Farms with ponds of 1 ha or larger were more likely to have been designed for the culture of other species (i.e. prawn or shrimp).

Tank and raceway culture: The use of tanks for the on-growing of tilapia has increased greatly in recent years. 38% of farmers interviewed employed tanks for on-growing tilapia, and a further 20% used them for tilapia reproduction and nursery. Circular tanks were used by 80% of tank on-growers, while elliptical and rectangular tanks represented 13% and 7% respectively. Concrete tanks were most common (73%), while 27% used cheaper options i.e. metal frames with liner or "trench" type tanks (lined-sand bag walls) (Figure 3.10). Tanks were mostly employed by private farms, with only 13% in the social sector, most probably due to their cost and managerial skills required to control water quality (Rakocy, 1989). In the southeast of Mexico (i.e. Yucatan and Quintana Roo), due to the lack of surface water and high soil permeability, the government decided to promote tilapia culture by using small round concrete tanks that could also be employed to irrigate their crops (Figure 3.11). Raceways were rarely used to culture tilapia; however, a few raceway farms have switched to tilapia from other species (like catfish, trout, spirulina, or shrimp) in order to stay in business.

Figure 3.10 Tilapia culture tanks; trench type (top left), lined metal frame type (top right), concrete-circular (bottom left) and concrete-rectangular (bottom right).

Cage and enclosures culture: Three systems were used for tilapia culture in large water bodies; “jaulas”, “corrales” and “encierros”. Jaulas are floating cages that do not normally touch the bottom of the body of water in which they are situated. Corrales were net pens that used staked sides allowing the bottom net to rest on the bottom or forsake a bottom net altogether. An interesting variation was the use of “encierros” (confinements or enclosures), wooden structures enclosing portions of a lagoon (Fitzsimmons, 2000a). Two types of jaulas were used in Mexico; one commonly used by low income social groups or individuals, used inexpensive local materials (FONDEPESCA, 1981) (Figure 3.12). The other type, in more intensive production systems incorporated floating docks, custom-made nets and other materials specially made for net pen culture.

Figure 3.11 Round tanks used by the social sector in Yucatan, Mexico.

Figure 3.12 Cages used by the social sector to culture tilapia in Alvarado lagoon, Veracruz (left) and river Champoton, Campeche (right).

62% of the cage farm operators interviewed belonged to the social sector, and the remaining 38% were private business. Cages sizes ranged from 3 to 90 m^3, the most common size being 4.5 m^3. Smaller sizes were normally employed by the social sector. According to Fitzsimmon (2000a) cages were important for growers who wished to control reproduction in their systems. Cage culture greatly reduced fertilization and recovery of eggs by the spawners if the eggs fall through the net mesh. Harvest from cages was also less complicated than recovering fish from a larger, open body of water. However, the most probable attraction for tilapia growers was their low cost; a reason why they became the choice of preference for rural aquaculture development programs. Most of the reservoirs where these cages were placed have been filled within the last 20 years and are used for irrigation, thus eutrophication of reservoir waters or fouling below the cages has not become an issue in most of the cases since tilapia faeces often float and break up readily. Nevertheless, there had been few cases of massive kills due to eutrophication, caused in most cases by lack of water exchange in the reservoirs due to long dry seasons.

Production management techniques

Stocking periods

Stocking depended on a number of factors, based on local availability of fingerlings, application of single or multiple stocking, funds, number of production units available and targeted sales period. Fingerling stocking was typically carried out more than once a year (Figure 3.13), with stocking every 5 – 8 months (twice a year average) as most common (33%), followed by monthly stocking (28%) and every 2 – 4 months (4 times a year average) (25%). Larger businesses most commonly employed multiple stocking throughout the year, while small businesses only once.

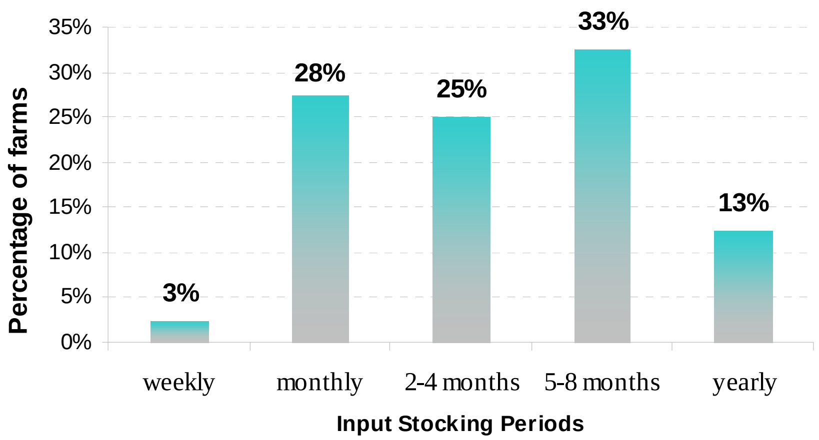

Figure 3.13 Tilapia fingerlings stocking periods on farms in Mexico.

Length of culture cycle

This was influenced by various factors; the most important amongst farmers interviewed were product size targeted, selling period, local environmental conditions, water quality, feed (quality and availability) and husbandry techniques employed. As shown in Figure 3.14, the length of the culture cycle most commonly reported were two: between 8 – 10 months (47%) and 5 – 7 months (43%), only 10% employed between 11 – 13 months. The shorter period (5 – 7 months) normally yielded a product of around 300 g (commonly expressed as 3 fish per Kg or 3:1), while 8 – 10 months a product of around 500 g (2 fish per Kg or 2:1), and the latter (11 – 13 months) a product of around 850g (1 – 1.5 fish per Kg or 0.75-1:1). This shows the preference of tilapia farmers for the production of small (<350 g) and medium (~500 g) size products. However, many authors had claimed obtaining similar sizes in shorter periods by using improved strains, technology and husbandry techniques.

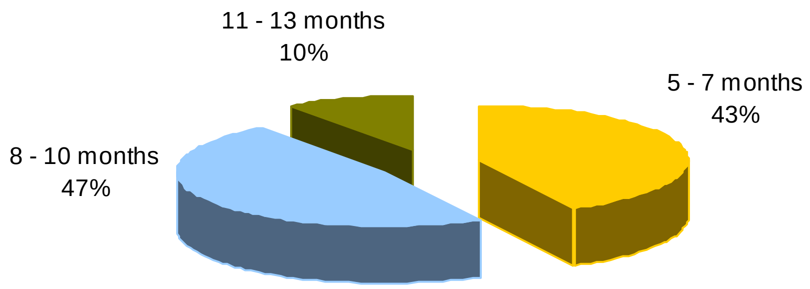

Figure 3.14 Length of culture cycle for tilapia culture in Mexico.

3.4.3 Key inputs

Staff / Labour

No official figures were available on the labour employed in the sector. The study found that labour on tilapia farms was typically based on people from nearby villages, whose main activity used to be agriculture. Staff members employed ranged from 1 to 14, with a median of 3.5 per farm. Numbers employed varied in relation to farm size, and type of system, i.e. pond farms' median was 6 members (range 1 to 14), while for both cage and tank farms the median was 8 (range 1 to 10 for the former, 1 to 8 for the latter); suggesting the small size of most businesses.

Tilapia production experience of most farmers interviewed was minimal, 77.5% had less than 5 years, almost 20% less than a year; 15% had 6 – 10 years and only 7.5% more than 10 years. Most experience was found amongst farmers in the private sector, normally of larger size. This shows the level of immaturity of the industry and highlights a sensitive issue. Investors found it difficult to hire experienced staff, with a high percentage of unsuccessful experiences, discouraging new entrepreneurs.

Water

Water availability was determined by tilapia farmers as a limiting factor for production due to the costs involved. Water supply was directly related to the type of system used. As showed in Figure 3.15, tilapia farms interviewed had four sources for water supply: wells, river/canal, lake/reservoir, and the sea. Supply of pond farms was mainly through wells (64%) and river/canal (36%); while tank farms mainly from wells (71%) and river/canal (24%), and from the sea (6%). Cage farms used mainly lake/reservoirs (67%) and river/canal (33%). This shows the strong dependence of wells, which normally result in higher costs, e.g. permits, exploration, construction, maintenance and electricity.

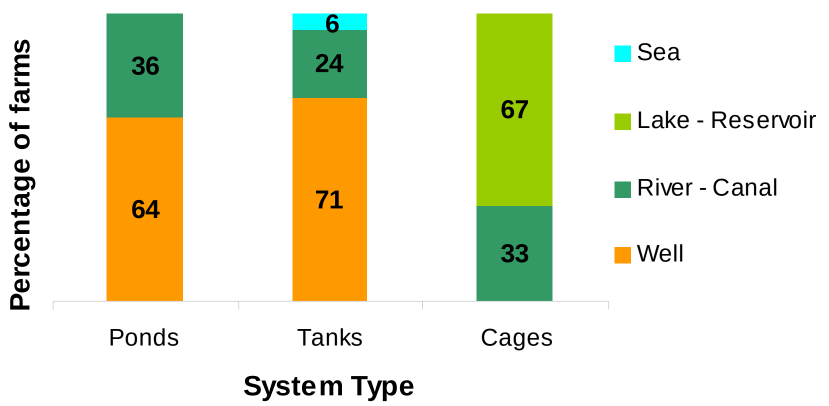

Figure 3.15 Water supply employed for tilapia farming relative to system type.

Fry

Tilapia farms interviewed had three options of fingerling supply, self-sufficient (close cycle), private hatchery and government hatchery. Almost half (47%) of farms produced their own fingerlings; 30% were supplied from private hatcheries and the remaining 23% from a government hatcheries (Figure 3.16). Thus 77% were supplied from private hatcheries. Most fingerlings used were sex-reversed, and only 8% of farms reported using mixed-sex fingerlings (Figure 3.17); probably due to high cost or lack of local availability, and in one case, aiming for an organic product. The peak of fingerling production in the majority of the hatcheries was just after winter (i.e. March – April), when temperature rises. However, supplies were usually available all year round, mainly from private hatcheries. The species most produced was Nile tilapia (*O. niloticus*), and in a lesser extent, red Mozambica (*O. mossambicus*).

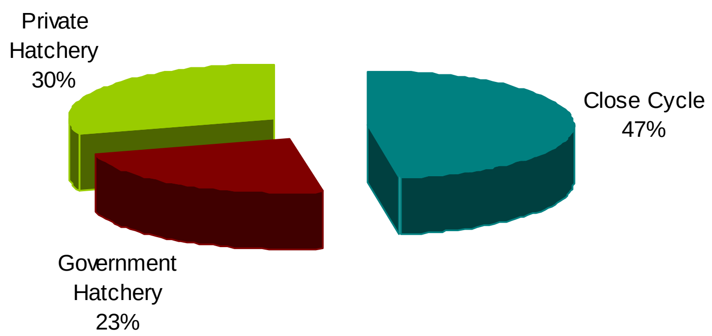

Figure 3.16 Proportion of tilapia farms producing their own fingerlings or supplied by governmental or private hatcheries.

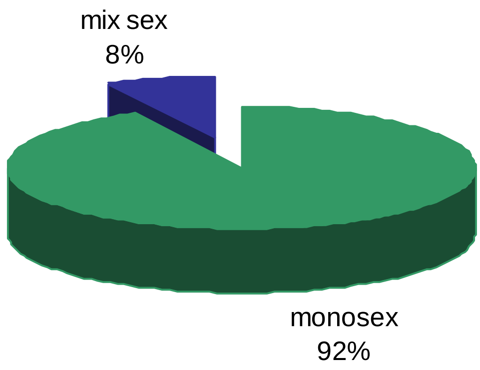

Figure 3.17 Proportion of farms employing monosex tilapia fingerlings.

Governmental hatcheries

There were 25 government aquaculture centres, producing about 68 million fingerlings in 2003 (Table 3.3). Species more commonly produced were blue tilapia (*Oreochromis aureus*), Nile tilapia (*Oreochromis niloticus*), and red tilapia Mozambican (*Oreochromis mossambicus*) (Table 3.4). Only three out of the 25 hatcheries sex-reversed the fingerlings.

Feed

Three types of feed were used; commercial feeds, farm-made feed and (enhanced) natural productivity. Commercial feeds were used by the majority (92%), compared with 3% and 5% using the others, respectively (Figure 3.18). Commercial feeds were available in most of the country; though most feed companies were located within the more industrialized north and urbanized areas of central Mexico, sometimes making it difficult to supply more remote areas, where simple feeds were sometimes used, from locally available materials prepared by hand or using meat grinders. Several feed companies formulated especially for tilapia while some poultry feed mills were also reported to make custom tilapia feeds (Fitzsimmons, 2000a).

Table 3.3 Governmental tilapia aquaculture centres in Mexico (Castañeda-Castillo, 2003).

Aquaculture Centre	N° of Fingerlings x 1000
El Varejonal, Sin.	13,150.0
Chametla, Sin.	8,435.5
Sontecomapán, Ver.	5,916.0
Pabellón de Hidalgo, Ags.	5,612.9
Temascal, Oax.	4,368.7
Benito Juárez, Chis.	4,251.0
San Cayetano, Nay.	4,063.1
Jala, Col.	2,976.4
Julian Adame, Zac.	2,511.0
Zacatepec, Mor.	2,409.6
Puerto Ceiba, Tab.	2,047.9
Aguas Blancas, Gro.	1,817.0
El Rodeo, Mor.	1,804.4
El Pataste, Chis.	1,326.0
La Tortuga, Ver.	1,242.0
Jaral de Berrio, Gto.	1,150.0
Calamanda, Qro.	1,031.3
Valle de Guadiana, Dgo.	1,014.9
Los Amates, Ver.	979.9
Tancol, Tamps.	629.6
El Saucito, Col.	488.1
La Rosa, Coah.	415.8
La Boquilla, Chih.	183.5
Tebanca, Ver.	38.8
Potrero Grande, Col.	10.0
Total	***67,873.1***

There were five major commercial feed suppliers, Ralston Purina (“Purina”), Aceitera Las Juntas (“AS”), El Pedregal, Malta-Cleyton and Algimex. Purina was the major supplier (used by 27% of farms interviewed) (Figure 3.19); followed by AS and Pedregal (20% each), Malta-Cleyton (15%) and Algimex (10%). Algimex was the only feed plant in the south (Yucatan State), the rest located in the centre (Jalisco and the State of Mexico) and Northwest (Sinaloa and Sonora). Most hand-made feeds were of the sinking variety; while, floating feeds were supplied mainly by commercial feed companies. Most cage operations used floating or slow sinking pelleted feed, while pond and tank farms employed mostly floating feed. Commercial feeds had a variety of protein levels, the most common being the 30% (average) protein formulation. These diets tended to be low in fish or animal meals, with a major portion of the protein being provided by soybean oil meal (Fitzsimmons, 2000a).

Table 3.4 Quantity of tilapia fingerlings produced in government aquaculture centres by species and variety (Castañeda-Castillo, 2003).

Species	Millions of fingerlings
O. aureus	40.537
O. niloticus	17.453
O. niloticus var. Stirling	5.216
O. niloticus var. R. Mountain	3.714
O. mossambicus (red)	0.953
Total	***67.873***

Natural productivity was based either on phytoplankton or duckweed (*Lemna minor*) blooms, typically promoted by using manure or recycling the tilapia excretions. For the latter, a farm employed a pond area ratio of 3:1 (duckweed: Tilapia) using separated ponds for production of tilapia and duckweed and recycling the outflow water from the tilapia ponds into the duckweed ponds.

Food conversion ratio (FCR) on farms using commercial feed varied between 1:1 and 2.1:1 (Kg feed : Kg fish). Although 23% of the farms were not able to report their FCRs, values most commonly reported were between 1.6–1.8:1 (35%), followed by 1.3–1.5:1 (20%) and 1.9-2.1:1 (15%); while only 8% reported FCR’s between 1-1.2:1 (Figure 3.20). Feeds with the lowest average FCRs were Algimex (1.4:1) and Purina (1.5:1), while the rest (AS, Pedregal and Malta-Cleyton) had an average of 1.7:1. Farm-made feed FCR was 1.6:1, while duckweed was 20:1.

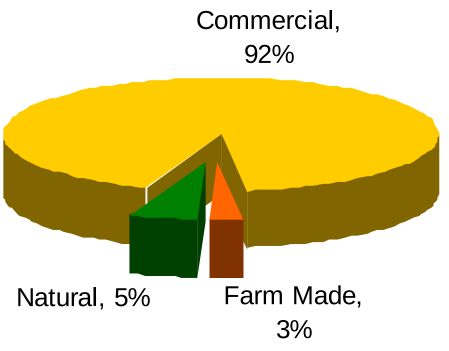

Figure 3.18 Types of feed employed.

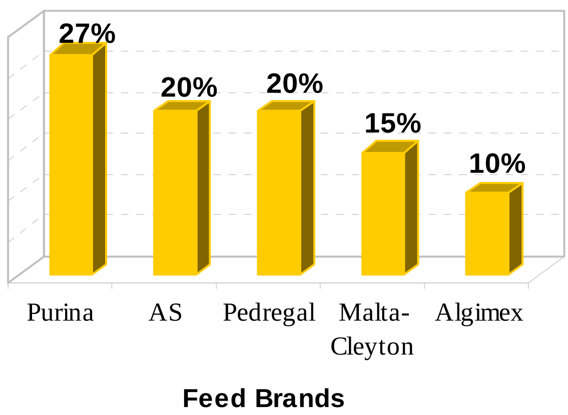

Figure 3.19 Major brands of tilapia feed employed.

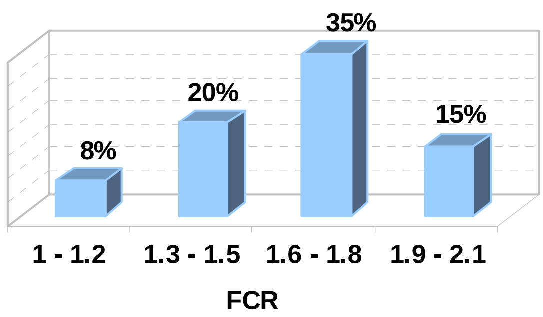

Figure 3.20 Food Conversion Ratios (FCR) in tilapia farms interviewed.

Public Services

Public services available depended on the level of investment and distance from urban areas. Those more readily available to farms interviewed were: access roads (97.5% of the farms), electricity (80%) and public transport (75%). Those less available were tap water (50% of the farms), gas (55%) and telephone (62.5%) (Figure 3.21). This shows that most tilapia farms had access to at least the main services required for their proper development (i.e. roads, electricity and public transport).

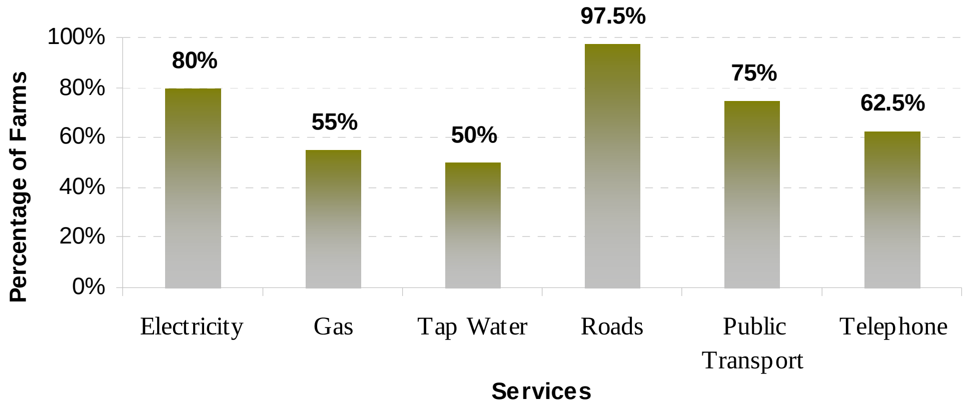

Figure 3.21 Public services available on tilapia farms.

3.4.4 Production, harvest and sales

Production levels

The majority of the tilapia farms were of small scale; outputs of 85% of farms interviewed fell within the 0 – 99 t per year level, only 15% producing over 100 tonnes per year (Figure 3.22). All major producers belonged to the private sector, and employed ponds or tanks. As the majority (78%) of the farms were fairly new, having less than 5 years operating record, many (54%) reported increasing outputs from previous years. 18% reported having no change and 28% experienced declined outputs. According to farms interviewed, increased outputs were attained mainly through business expansion and/or technology improvement. The main reasons of having no change in outputs were because they were just starting (less than a year) or had reached their production target. Declining productions were normally as a result of poor management, bad weather, lack of availability of consumables (mainly feed and fingerlings), lack of funds and legal problems (eg. the lack of interest by the State Quintana Roo in promoting tilapia due to ecological reasons). Some 60% of farms interviewed reported using a portion of production to another purpose rather than sale, i.e. self-consumption, bonus-payment to staff members, donation or under-size/poor quality. However, 53% used less than 5% of the production.

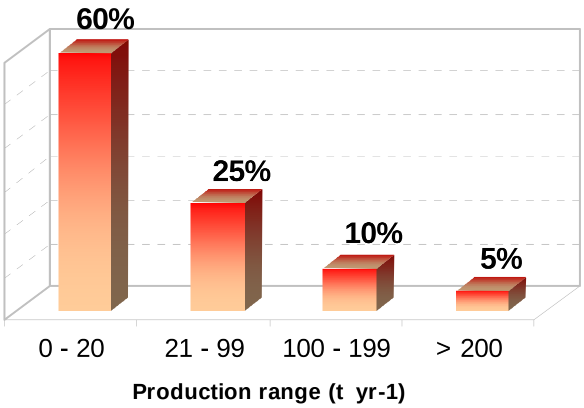

Figure 3.22 Production range (t yr^{-1}) of the tilapia farms interviewed.

Harvest technique and periodicity

Most farms harvested their product partially, only 30% of those interviewed applying total harvests. Harvest was predominately carried out manually, only 5% had mechanisation.. Seine and hand nets (dip nets) were the main types, though cast nets were used when small amounts were required. Almost half (47.5%) of farms interviewed reported harvesting (partially or fully) on a weekly basis, while a further 15% harvested up to 6 times a year (Figure 3.23). Almost 38% of farms harvested at the end of the culture cycle, with 18% harvesting twice a year and 20% only once a year. The selling period or times most commonly targeted were Easter and Lent, when seafood is in great demand in the whole country. Winter was also recognised by some farmers as another period of high demand.

Nevertheless, tilapia was in demand all year round and was reported to be sold with no problems at any time of the year.

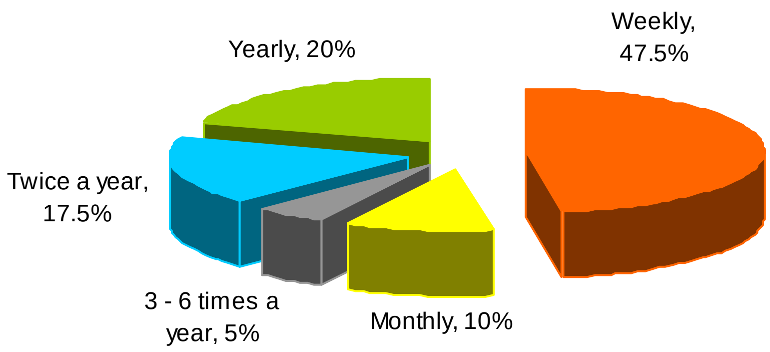

Figure 3.23 Harvest periodicity of tilapia farmers.

Post-harvest handling

The ideal handling practice after harvesting was to kill-chill (euthanize) the fish, assuring delivery of high quality product with ethical handling techniques. However only 30% of farms interviewed kill-chilled; in many cases it was not practiced because of small volumes traded or short distances to final destination. So how was killing done? Ice was readily available all round the country at reasonably low price (between MX$3 – 10 per Kg).

Farmers sold their product mainly in the whole-round and gutted form; the former for 55% of the farms interviewed, the latter by 45% (Figure 3.24). Other forms sold at the farm gate included live (used by 18% of the farmers), gutted-scaled (10%), fillets (7.5%) and cooked (5%). Only 7.5% used some sort of packing.

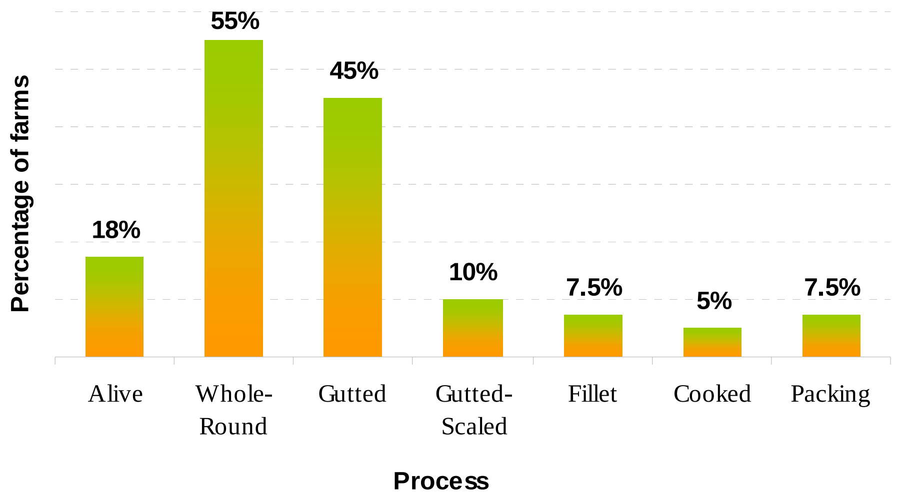

Figure 3.24 Type of processes applied to farmed tilapia.

Product size

The most common product size was 350 to 550 g, typically defined as medium size or 2 - 3 fish per Kg. Figure 3.25 shows how most (93%) farms sold this size; whereas 50% reported selling small size tilapia (<350 g) and only 45% large tilapia (>550 g).

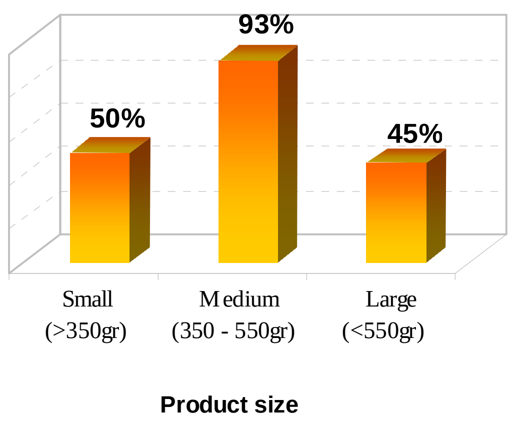

Figure 3.25 Product sizes (percentage of farms).

Factors influencing the production of a particular product type

According to the farmers interviewed, the main factors influencing their decision for selling a particular product were, demand (68%), feasibility for producing and selling (45%), price sold and profits achieved (38%) and yield obtained (10%). 30% of farmers reported changing the presentation of product sold, by switching from small to medium size and from more to less processed products. The former was mainly due to demand for larger sizes; and the latter due to dealing with wholesalers rather than selling directly to consumer.

3.4.5 Tilapia sector performance

Production costs

Fitzsimmons (2002) described the estimated production cost of tilapia in some major producing and consuming countries. In which Mexico appeared closer to the more expensive end, with the third most expensive production cost (US$ 1.2 kg^{-1}); just after Canada and USA (US$ 2.10 and 2.00 kg^{-1} respectively). While major producers (i.e. China, Philippines, Indonesia, Brazil, Ecuador, Thailand, Honduras and Costa Rica) reported costs 45 to 25 % lower than Mexico (i.e. between US$ 0.80 to 0.90 kg^{-1}). Suggesting the economic disadvantage of the Mexican farmed tilapia compared to major producing countries. Additionally, this also shows one of the main weaknesses of tilapia farming in Mexico; and therefore, one of the key issues that the Mexican producers need to address in order to be able to compete, especially when considering the increasing supply of high quality imported products to the Mexican market.

According to the research findings, production costs (based on major operational costs, i.e. seed, feed, electricity and labour) for gutted farmed tilapia in Mexico ranged from as low as MX$ 3 kg^{-1} to as high as MX$ 65 kg^{-1}, with a median value of MX$ 19 kg^{-1}. Nevertheless, as shown in Figure 3.26, production costs were directly related to the level of production. Were businesses with outputs over 100 t yr^{-1} reported production costs more than half lower (median value MX$ 11.7 kg^{-1}) than smaller businesses (< 100 t yr^{-1})

(median value MX$ 24.3 kg^{-1}). Also important to notice from the figure, is the greater disparity of the range in cost of smaller businesses (between MX$ 3 – 65 kg^{-1}) compared to larger (between MX$ 9 – 18 kg^{-1}). In which extreme low values in small businesses were normally as a result of subsidies, while higher end values due to bad management and expensive inputs.

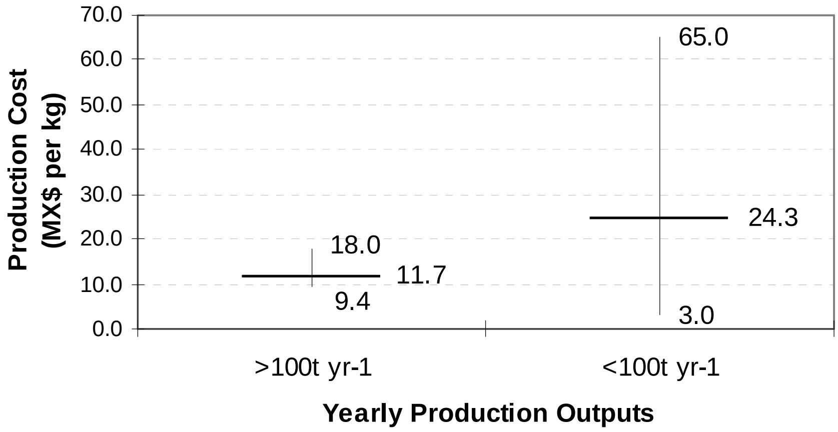

Figure 3.26 Unit production cost (MX$ kg-1) of farmed tilapia businesses, according to production outputs (median, and range values).

Furthermore, production costs also varied according to the culture system type employed. Figure 3.27 shows how production costs median value for pond cultures (MX$ 13.5 kg^{-1}) was a third lower than tank and cage cultures (MX$ 20 and 22 kg^{-1} respectively); most probably as a result of the implementation of less intensive cultures and the fact that capital cost were not considered. Also, the highest (MX$ 65 kg^{-1}) as well as the lowest (MX$ 3 kg^{-1}) values were reported in businesses employing this type of system. Higher values reported not only in pond cultures but on all type of systems, were normally linked to poor management, inexperience and small outputs; whereas lower values to higher outputs, experience and the employment of efficient technologies (e.g. intensive cultures, natural productivity as feed source and integration).

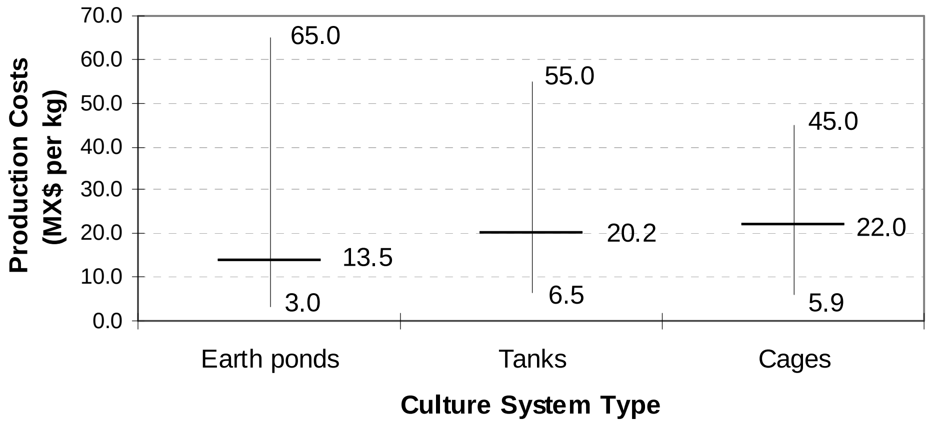

Figure 3.27 Unit production cost (MX$ kg-1) of farmed tilapia by culture system type (median, maximum and minimum values).

The research also looked at the main factors involved in the production costs of farmed tilapia in Mexico. As shown in Figure 3.28, feed represented the major production cost by far, with a median value of 54% and ranging from 10 to 92% of the costs. Other major costs were labour (median value 18%, ranging between 0 to 57%), fingerlings (median value 10%, ranging between 0 to 51%) and electricity (median value 4%, ranging between 0 to 77%). These values matched the typical proportions of operating costs in tilapia farming worldwide described by Young et al. (2000), i.e. feed and fertilizer usually as the major cost (typically 40-75%), followed by seed (5-25%) and labour (5-15%). Which highlights the need for careful handling, administration and decision of the feed employed.

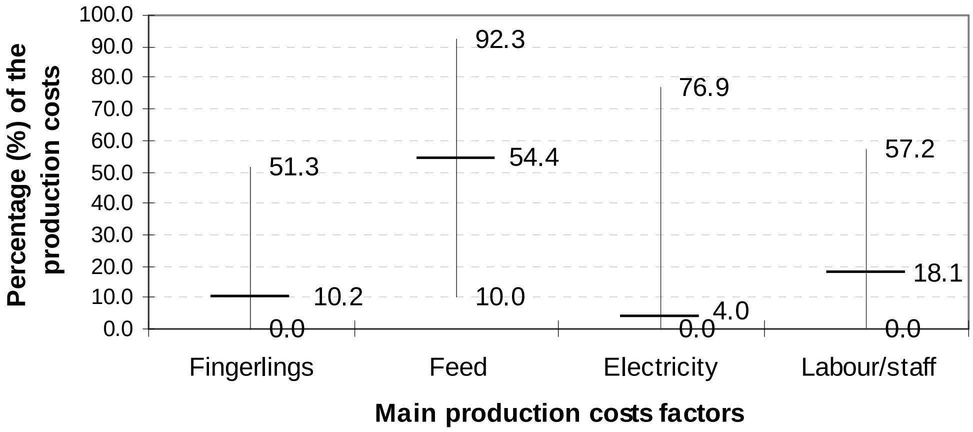

Figure 3.28 Percentage (%) of the production costs of farmed tilapia according to main production factors (median, maximum and minimum values).

Sources of income

For most farms (83%) interviewed tilapia farming was not the only source of income; this was mainly for farms just starting or those whose existence served secondary purposes. Other sources of income for farms interviewed were production of other aquatic species (25%), agriculture (20%), livestock (15%), other businesses (40%) and another job (28%) (Figure 3.26). Income from other businesses was the main source for 35% of the farmers, followed by tilapia farming (25%), another job (15%), agriculture (12.5%), production of other aquatic animals (7.5%) and livestock (5%).

Performance perception

Perceptions of the performance of tilapia farming in relation to other sources of income varied amongst farmers. Figure 3.27 shows how it was perceived as more profitable and feasible[19] for the majority of the farmers (57.5% claimed to be more profitable, and 52.5% claimed to be more feasible); however, more farmers claimed tilapia farming was less feasible (42.5%) compared to the other sources of income, while only 30% claimed it was less profitable. Perceptions as to whether tilapia farming improved their socio-economical situation were divided, 52% said it helped to improve, while 40% claimed the contrary and 8% said it remained the same. The main reasons given on why it did not help was because farmers were just starting, high production costs, low production outputs and too many people involved in the business (mainly for farms belonging to the social sector, such as cooperatives).

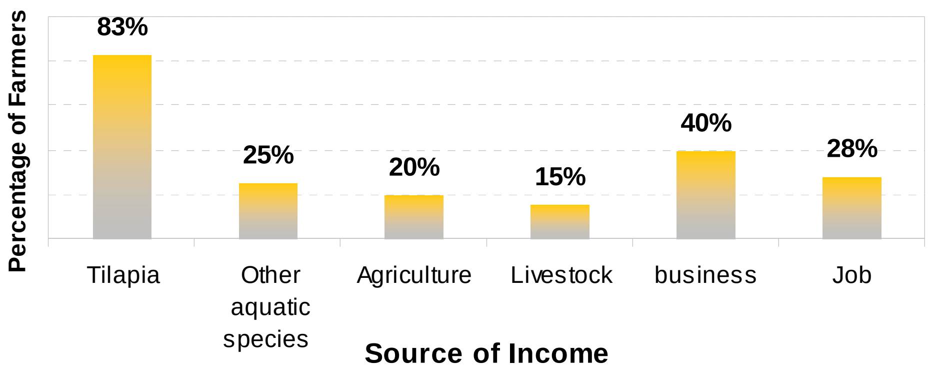

Figure 3.29 Tilapia farmers main sources of income (percentage of farms).

[19] Viable for production in relation to knowledge, effort and time demanded and market oportunities.

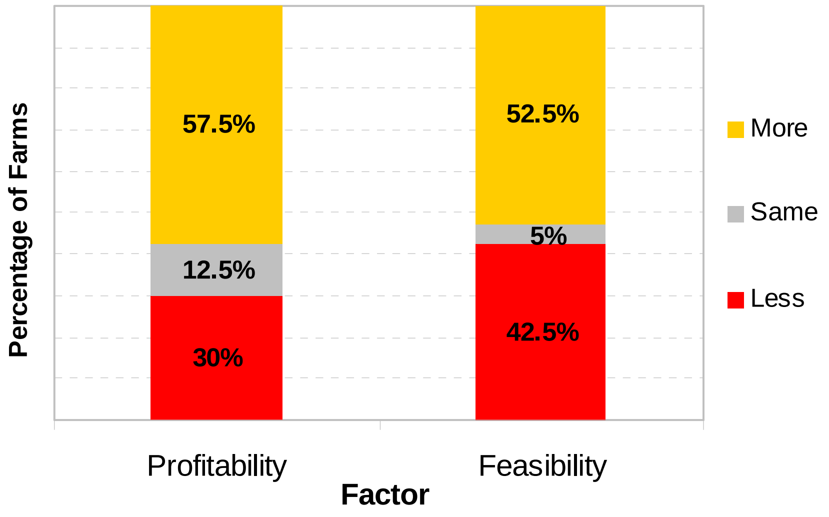

Figure 3.30 Farmers perception on the profitability and feasibility for tilapia farming (percentage of farms).

Potential improvements

According to farmers interviewed, there were three major factors improving tilapia farming: improved technology, improved husbandry and other factors. Main improvements in technology included improved strains, better infrastructure, more widely available and specialised equipment, better materials and better feeds at lower prices. Major husbandry improvements included better protocols, control of water quality and improved reproduction, feeding techniques, stocking densities, market perception, staff management, site selection and integration with other activities. Other major improvements included experience, associations, governmental support, relationships, expansion, consultancy and lower electricity tariffs.

Constraints

Major constraints to development according to farmers interviewed included, high costs of consumables like feed, electricity and initial investment; poor availability or supply of fingerlings, feed, electricity, consultancy and financing; low prices of tilapia and strong competition from fisheries and imported products; bad weather, lack of experience and poor management, design of systems, strains employed; diseases; regulations, corruption and associations; poor sex-reversal and heterogeneous sizes at harvest. Main constraints found by the study are summarised as:

~ Poor monitoring of farms by government institutions, resulting in little information of their actual number and distribution.

~ Proper technology was already available. However, strong competition from government hatcheries inhibited development of the commercial sector, reducing competition, limiting use of improved technologies, and wider availability of suitable quality seed (e.g. sex-reversed, with good growth).

~ Although cage culture was promoted in some fisheries, development programs failed to monitor, assess and improve their performance; as well as to consider and promote their potential throughout the country.

~ Very few tilapia farms integrated with other agricultural activities and/or other related businesses, placing them at a disadvantage with larger competitors.

~ Few tilapia farmers employed staggered stocking or harvest, though this was starting to increase. This often resulted in poor monitoring of the live inventory, and thus the actual performance of the farm was rarely known.

~ Key production costs (e.g. water supply, feed and electricity) were commonly higher compared to other agri-businesses (i.e. agriculture and livestock).

~ No major developments were found in relation to the reduction of the time required to achieve market size.

~ A major constraint for medium and large scale producers was their production of a small (~350 g) and medium size product (~500 g) traded in the whole-round and gutted form, which competed directly with cheaper and poorer quality products from the catching sector.

- Widespread inexperience resulted in a large number of unsuccessful businesses and the discouragement of new entrants.

- Many producers targeted their production for the high season only (i.e. Easter), so they could achieve higher prices; however, due to this, they were ignoring potential clients that required constant supplies.

- Only a few producers practiced kill-chill after harvest, and so opportunities were missed to reduce the rapid deterioration of the quality of their product.

- The majority (85%) of tilapia farmers are of small scale, producing less than 100 t per year; which places them directly at a disadvantage with other sources that are supplied in much larger volumes.

3.5 Conclusions and future trends

3.5.1 Conclusions

These are summarised as follows:

Fisheries-aquaculture

- Although tilapia represents the major inland fishery in Mexico, found all over the country, and becoming an important factor for development in rural areas, the industry seemed to be inadequately developed, commonly employing rustic technologies for production and processing, and poor regulation enforcement and support, inefficient infrastructure and inexistent marketing strategies.

~ The downturn trend of the tilapia fisheries outputs in Mexico is more likely to remain the same due to the complexity of the issues involved, in particular poor management.

~ As outputs have been severely diminished in many fisheries, a few organised fishermen (normally within the same cooperative) were attempting to increase their outputs through tilapia cage culture in the same water body, commonly as a complementary activity. This first suggests the increasing perception of fishermen on the lucrative potential of tilapia farming; and secondly, the successful outcome of governmental efforts to promote tilapia farming within the social sector. As a result, an increasing number of tilapia farmers from the social sector were looking at expanding their operations to become commercially viable and be able to depend solely on farming.

Industry structure

~ The tilapia aquaculture industry is small and their share in the domestic market is insignificant, mainly as a result of the small number of commercial producers of large outputs. However, the industry have seen an increasing flow of new entrants and improved support schemes.

~ Tilapia farming proved to serve various objectives apart from a main source of income, e.g. eco-friendly and complementary aims of a particular business.

~ Tilapia farming was perceived as more profitable than feasible, as many farmers considered the activity as more risky and more difficult to compete with cheaper source.

Production costs

- ~ Tank culture seemed to be the preferred system employed, though normally considered as an expensive and highly skilled option, the availability of newer, simple and cheaper options had increased its use even further.

- ~ Cage culture has huge potential, especially amongst the social sector; however, it was only promoted in some areas and monitoring was poor.

- ~ Pond cultures resulted in lower production costs in overall, though mainly as a result of the employment of cheap and efficient technologies.

- ~ Economies of scale in tilapia farming in Mexico proved to be twice more economically efficient than smaller businesses (< 100 t yr^{-1}), with production costs 50% lower (i.e. median value MX$ 11 kg^{-1}).

- ~ There was a widespread lack of understanding of the benefits of integrating tilapia farming into other agricultural activities (diversification) and/or with other related businesses (i.e. horizontal-vertical), which could promote efficiency and profits. This included not only integration with agriculture and livestock, but also polycultures (in particular shrimp, catfish and bass) and cluster partnerships (FONDEPESCA, 1984).

- ~ Higher production costs place Mexico in disadvantage to other large producers. Figures reported during the research suggested that particular attention should be given not only to the type of feed used and its cost, but also to its proper administration and performance; which require advanced management skills.

- ~ Nevertheless, these values should be considered with caution as normally these issues resulted to be sensitive to farmers, therefore commonly giving discrete responses and not 100% reliable.

Development of key inputs and services

~ Proper technology for tilapia farming was available, though poor technology transfer and an unwillingness to share knowledge from more experienced producers, access to expertise difficult for new entrants, resulting in large numbers of unsuccessful businesses and the discouraging of new entrants.

~ There is a strong preference for sex-reversed fingerlings, in particular of Nile tilapia, as the activity has proved to be well adopted within the industry, but this was not well supplied.

~ Increasing year round demand for high quality fingerlings required well developed hatcheries across the country. However, unfair competition from government hatcheries commonly deterred new entrepreneurs.

~ Commercial feed was readily available though their high price represented an important share of the production costs. There was a clear need to develop a closer relationship between producers and feed companies in order to achieve a more balanced win-win situation between them.

Market sizes and availability

~ Many tilapia farmers produced small and medium size products, and traded in the whole-round and gutted form, forcing them to compete directly with cheaper sources such as products from fisheries or imported. Opportunities were limited for extending the production period to achieve larger sizes, for using improved technologies to attain market sizes in shorter periods (e.g. better strains, feeds, systems, husbandry techniques, etc.), and/or produce added value products like fillets, might allow them to access more profitable markets or speed cash flow.

~ Seasonality of fishery product supply should be taken into account by farmers, as this would allow them to program harvest achieving better prices.

- Farmers should consider targeting clients requiring constant supplies rather than selling their product in only one season, as this will allow them to tackle cash flow problems and to have more stable and dynamic business.

3.5.2 Future trends

Mexico is already one of the world's major tilapia producers. With an expanding population and increasing standard of living, domestic demand is bound to increase. Proximity to the US also provides a huge potential market. However, contrary to what was predicted five years ago by the World Bank Economist, national production has seen a decline for the past few years. A situation that will continue if fisheries fail to improve their management practices. On the other hand, Mexico has tremendous natural and technical resources for tilapia production, as well as having success utilising culture methods ranging from extensive to intensive. Low cost labour is available for low skill jobs on the farm, but at the same time Mexico has many well trained biologists who are capable of handling the most technical positions at intensively managed farms (Fitzsimmons, 2000a). Nevertheless, the main trends found in the study are summarised in the following points:

- Potential to develop tilapia farming in regions distant from major fisheries, in particular northern states.

- If technology transfer schemes are improved, larger numbers of successful businesses could be expected, attracting even more entrants to the industry.

- As some governmental hatcheries start selling their fingerlings, this will encourage new entrants in this particular sector of the industry.

- Tank culture will continue to be the preferred type of system employed for tilapia culture due to availability of improved, simple and cheaper technology. Whereas pond culture might expand more rapidly in businesses that culture other species, like shrimp, prawn, catfish and bass; and cage culture in major fisheries within the social sector.

~ Efficiency and profits would be more readably attained by small and medium farms if integration is pursuit.

~ As competition for small (~350 g) and medium (~500 g) tilapia products in the gutted form gets harder, tilapia farmers maybe forced to produce larger sizes, value-added products or reduce costs by reducing culture lengths and employ more efficient techniques.

~ The employment of sex-reversed fingerlings are expected to be demanded by most tilapia farmers as the techniques employed for their production prove to be readily available across the country, cheap and simple to follow.

~ Sex-reversed Nile tilapia will continue to be the specie of preference for tilapia culture in Mexico.

~ Better relationship and involvement from feed companies with producers should be expected as competition between feed companies to increase market share becomes harder.

~ Tilapia aquaculture outputs are expected to increase dramatically as the number and size of producers rise rapidly.

The next chapter (Chapter 4 Tilapia marketing in Mexico) present the results of the research findings in relation to tilapia marketing and the positioning of farmed products.

Chapter 4 Tilapia marketing in Mexico

4.1 Introduction

In the past, people in Mexico had a low regard for tilapia due to the undesirable features of some species (i.e. the darkness of *0. mossambicus*) and their poor handling (resulting in poor quality). Other species (i.e. *0. niloticus*) however, have many attributes that encourage its culture (Torres et al., 1985), examples include excellent growth rates on low protein diets, tolerates wide ranges of environmental conditions, has little susceptibility to diseases and is amenable to handling and captivity (Balarin and Haller, 1982; Edwards et al., 1990; Jauncey and Ross, 1982; Plumb, 1997; Pullin et al., 1994; Suresh and Lin, 1992; Viola et al., 1988; Yakupitiyage, 1993; Yang et al., 1996). In addition, it has desirable market characteristics that appeal to consumer's tastes, such as soft flesh, firm texture, large size and palatability. Nevertheless, because of the relatively late entry of tilapia production in Mexico, few studies have been carried out on the subject. Fewer still have been the studies on the marketing aspects of the species.

As mentioned by Young et al. (2002), “the fisheries sector has been slow to adopt the concept of marketing, with a few exceptions. Historically the emphasis has been on fish stocks and production, and this broadly continues, in catching what there is to be caught rather than selectively delivering what the market prefers. Even in aquaculture, a primary focus has been on system capacity and production output. In most cases, distribution systems have grown around this supply-driven base, with the onus on market agents to match consumer needs with the product available, rather than to proactively determine what might be supplied. Notwithstanding the deep-seated socio-cultural traditions, people go fishing not just to catch fish but also to generate income (Hannesson, 2002, in Young et al., 2002). Neither is aquaculture just about the technical achievements of farming aquatic species, enterprises have to deliver benefits too”.

This chapter discusses tilapia production and price trends, marketing flow and trading practices in tilapia in Mexico. The data are based on available secondary sources and on a study conducted among marketing organisations involved with tilapia, i.e. producers, wholesalers and retailers.

4.2 Tilapia supply to the Mexican market

Until recently, tilapia products were entirely supplied from domestic sources, based on fisheries and aquaculture. However, for the past few years external sources (imports) have become a rapidly significant source. As shown in Figure 4.1, most of the supply of tilapia products to the Mexican market had come from the catching sector (fisheries), representing 91.3% (66,215 t) of the total supply (72,486 t) in 2003, while the other two major sources, i.e. aquaculture and imports, accounted for only 1.3% (964 t) and 7.3% (5,307 t) respectively for the same year.

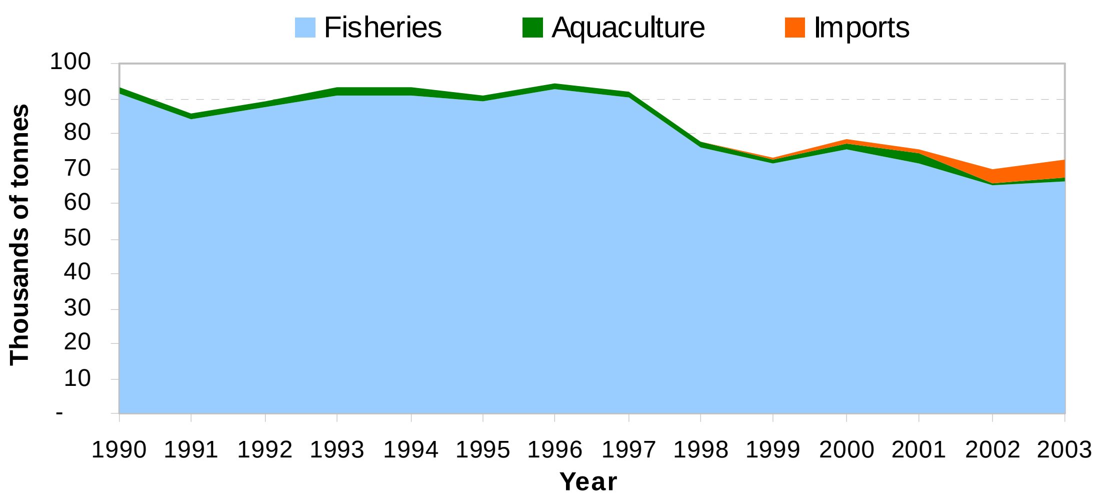

Figure 4.1 **Supply of tilapia products (in Thousands of tonnes) to the Mexican market between 1990 and 2003 by major sources (CONAPESCA, 2003; and NMFS, 2005).**

Moreover, although total supply decreased by 22.4% (-20,886 t) between 1990 (93,372 t) and 2003 (72,486 t), mostly due to fisheries (down 27.6% or -25,195 t) and aquaculture (down 50.8% or -997 t) outputs decline; as a result of demographic pressure, open access or ill-defined property rights, excessive centralisation of management decisions, and a wide array of market and regulatory disincentives for conservation (Compean, 2006; Enriquez and Batalla, 2001); imported products supply on the other hand, rose from nothing in 1990 to over five thousand three hundred tonnes in 2003. Nevertheless, as described in the previous chapter (chapter 3) fisheries were more likely to remain constant at best due to over-fishing through poor management and maximum outputs reached on the major fisheries. On the other hand, aquaculture and import supplies are expected to rise due to the increasing interest of governmental and private sectors on the former (Alvarez, 2003; Panorama Acuicola, 2005a) and increased demand by major traders of the latter (Diario del Itzmo, 2005; La Tribuna, 2005; Milenio, 2005).

4.2.1 External supply

Most of the tilapia supplied externally or imported to the Mexican market in 2003 came from China and Taiwan through USA and Canada, mainly via Los Angeles and San Diego in California, Huston in Texas, and Vancouver in British Columbia. However, there had been some imports of tilapia products from other countries like Canada, Cuba, Costa Rica, Honduras, Panama and Ecuador. Two main factors had promoted this situation; first, the 0% import tax on all goods from the US, thanks to the NAFTA (Kose et al., 2004; SE, 2005, 2006); and secondly, the fact that the US is one of the major importing countries of the world, attracting a vast amount of goods at very low prices, as a result of strong competition of large producing countries.

According to the importers, all imported tilapia products were more likely to be farmed, although this information was not stated in all products, some did have some sort of description of its origin, particularly vacuumed packed frozen fillets. Imports from USA and Canada were on the rise, while Latin American products were sporadic or in decline due to unbeatable price competition from the Chinese products. Major brokers (importers) in Mexico were located within major cities (i.e. Mexico City, Guadalajara and Monterrey) and bordering cites (i.e. Tijuana and Juarez City).

4.2.2 Type of products supplied

The type of tilapia products supplied to the Mexican market varied mainly in relation to the source:

Caught tilapia products

Tilapia products from fisheries, commonly known as "wild tilapia" by most traders, was supplied only in the fresh form, either gutted or filleted (Figure 4.2). However, only few fisheries filleted their catch, which normally was carried out by the middlemen or "coyote". Fisheries from the Centre-West and North of the country tended to trade their product filleted, whereas Centre-East and Southern fisheries traded their product gutted.

Size of the product caught was an important determinant on whether the product was going to be traded filleted. Fisheries catching small size tilapia (normally below 250 g live weight) filleted their product (e.g. Infiernillo and La Angostura), trading small fillets of around 35 g each, while fisheries catching medium to large tilapia (normally above 300 g live weight) traded their product gutted (e.g. Aguamilpa and El Salto) with product ranging from 250 g to 800 g.

Figure 4.2 Example of main tilapia products supplied by fisheries: gutted loose (left) and fillets in 5 kg bags (right).

Farmed tilapia products

Farmed tilapia products on the other hand, were traded by the farmers normally whole-round, gutted or alive (Figure 4.3); only one major farm had the infrastructure to fillet their product (PISIMEX), but is no longer producing in large quantities due to operational managerial problems, which forced them to switch to import tilapia products in the past few years. The live product was normally traded by small to medium size farms, whereas larger farms were more inclined to trade their product gutted. The former presentation (alive tilapia) was traded because of ease of handling, low volumes demanded and consumers preference for live product; whereas the latter (gutted tilapia), was traded in order to access larger markets with large volumes. Additionally, contrary to what is normally carried out within the fisheries sector, farmed tilapia fillets were between 57 – 113g (2 – 4 oz), requiring a harvest product of between 650 to 900g live weight.

Figure 4.3 Example of main tilapia products supplied by farms: whole-round (left) and alive (right).

Imported tilapia products

Imported tilapia products were traded in its great majority in the frozen form, and in various presentations: whole-round, gutted, scaled and filleted (Figure 4.4). However, there had been some attempts to import fresh fillets from Latin America, but had found fierce competition from the much cheaper frozen Chinese product. According to NMFS, in 2003

52% of the tilapia imported by Mexico from the USA was the whole frozen form (including whole-round, gutted and scaled), whereas the remaining 48% was made of fillets (frozen and fresh). The volume of imported fillet products was reached in that year, whereas five years before (1999), fillets used to represent only 6% of trade. The whole form was mostly traded gutted and scaled, while fillets were frozen and skinless. All products in the whole form were individually bagged using plastic bags (not air-tight or sealed) and packed in a master box of 40 lb (18.2 kg); while fillets were individually vacuumed-packed, also in masters of 40 lb.

Major advantages and disadvantages of each product type in relation to their source are summarised in Table 4.1. As can be appreciated, it clearly illustrates the great array of comparative advantages of farmed tilapia products. It also shows the large number of negative factors associated with wild products, and how imported products have come to address many of these issues.

Figure 4.4 Example of main imported tilapia products: gutted and scaled, individually bagged (left) and fillet individually vacuumed-packed (right).

4.3 Domestic demand for tilapia in Mexico

The type of tilapia products demanded varied in relation to the region; while in the North (especially North-West) and Centre-West tilapia was preferred by consumers as fillet or “ceviche”, in the Centre (especially Centre-East) and South was preferred in the whole presentation (including live, whole-round, gutted and scaled). Figure 4.5 gives an example of the main ways tilapia products were consumed in Mexico, with deep-fried as the most popular dish around the country.

Figure 4.5 Example of the main ways tilapia is consumed in Mexico: whole deep-fried (left), ceviche (centre) and breaded fillets (right).

In the overall picture however, tilapia seemed to be in greatest demand within the Centre and South of the country (including Coastal regions), whereas inland Northern regions were less keen on seafood, and Coastal-Northern regions seemed to be more attached to their traditional marine species. This behaviour could be explained by the greater number of people involved in the production of tilapia within Central and Southern regions (the majority of fisheries and farms were located within those regions), creating awareness and a tradition to consume the product. Additionally, as tilapia used to be considered as a cheap product of poor quality, Northern regions, which enjoy of a wealthier status compared to the centre and south of the country (UNDP, 2002), would prefer higher quality products.

Table 4.1 Advantages and disadvantages of the different types of tilapia products in relation to their source.

	Advantages	Disadvantages
Fishery	+ Lowest production cost + Supplied in large volumes + Suitable for value-added fresh products + Accessible to low-income population + Create jobs in isolated rural areas	- Unsatisfactory standards of handling - Small sizes - Unsatisfactory standards of processing - Poor monitoring - Unsustainable practices - Health risks - Poor perception - Inconsistent supply - No packing
Farmed	+ Supply the freshest products + Suitable for value-added fresh products + Suitable for traders seeking high quality fresh products + Promote general perception of the product + Health risks easier to control + Perceived as safer to eat + Create jobs in rural areas + Promote awareness in rural areas + Demanded by various sectors of the population + Open new market niches + Sustainable production is more feasible than other sources	- High production costs - Small volumes of supply - Inconsistent supply - No packing - Small product sizes
Imported	+ Second cheapest option + Suitable for value-added frozen products + Demanded by various sectors of the population + Good presentation + Good processing + Easy to handle + Available in large volumes + Consistent supply + Well packed	- Frozen products only - Un-known origin - Un-known handling - Un-known time from harvest - Unlawful introduction to the country

4.4 Mexican exports of tilapia products

According to NMFS (2005), Mexico exported tilapia products (mostly fresh fillets) to the USA from 1993 to 1999. However, only small amounts were traded (< 20 t yr-1). Product came normally from small fisheries and farmers located near the border with the USA, thus resulting to sell the product cross-the-border than transport it major domestic markets (e.g. the south of the country, Mexico City, Guadalajara and Monterrey). Since then there has been no reports of more tilapia exports to that country or any other, most probably as a result of the decline of fisheries supply, trade barriers and an attractive domestic market for traders. To give an example, fresh tilapia was sold in the retail market at around US$2 kg^{-1} in the US, while similar prices were achieved for the same product in Mexico, but without the hassle of the time, money and paper work for crossing the border (Roberto Duval, wholesaler, personal communication, 2003). These former exports were normally carried out to near-the-border cites in the US (e.g. El Paso, Laredo and Brownsville, Texas; Phoenix and Tucson, Arizona).

4.5 Role of major operators in tilapia marketing

The following sections examine the role played by each category in tilapia marketing.

4.5.1 Tilapia producers

Fishermen

Since tilapia was first traded in the country (around the late 60s), fisheries had been the primary source of tilapia products to the Mexican market until today. Therefore, the role of fishermen had been vital to the supply of this product to the Mexican market. Fishermen were normally organised in cooperatives or associations, often helped by family members and relatives. The marketing activity for the fishermen was pretty simple, most of them (including clandestine fishermen) sold their product to the middlemen; and only in some cases, their catch or part of it was sold to local restaurants and/or villages if available. According to Hernandez-Montaño (2006), around 40% of the fishery output in the lake Chapala was traded locally; the remaining 60% was traded to major cities within the region, i.e. Guadalajara, Morelia and Mexico City. Normally most of these fisheries were isolated and located in remote areas. As soon as people from rural areas realised that catching tilapia was less demanding and more profitable than working on agriculture or livestock, they started switching fully or partially to this activity. This encouraged rural people to stay and not migrate to other cities or countries in search for a better life, and also attracted people to these unpopulated regions.

Fish farmers

From the survey on tilapia farmers, it was found that the majority of the producers were of medium to small scale (< 100 t yr^{-1}), and only 15% (6 farms) reported higher outputs. Small to medium size farms normally belonged to the social sector, while medium to large farms were mostly private business. As it can be seen in Table 4.1, tilapia farming played various key roles in the development of the industry in Mexico, highlighting the availability to adapt to any market changes, offer high quality products, promote the perception of tilapia products mainly due to its freshness and health risk-free condition, create jobs in rural areas and promote awareness of fish products in inland rural areas and that sustainable production can be more easily achieved.

Nevertheless, although development and support programs were showing a real impact only in few states, there were a fast growing number of farmers belonging to both sectors, i.e. private and social, which are expected to play an important role in the supply of tilapia to the Mexican market (Alvarez-Torres et al., 1999, 2003; Fitzsimmons, 2000a), at least greater than imports in the short term. Especially when considering the complexity of the catching sector's issues and the eventual regulation (i.e. proper taxation) of imported products.

4.5.2 Tilapia wholesalers

Wholesaling of tilapia products was typically carried out by four marketing operators; middlemen, importers, processors and wholesalers *per se*. According to INEGI's (2004) national economic census, there were 365 companies' wholesaling seafood (excluding processors) registered in Mexico, and employing 4,147 people (excluding processors); representing nearly 22% of the total businesses (around 1,650 meat wholesalers) and nearly 18% of the people employed in wholesaling meat products (around 23,000 employed).

Middlemen

Most of the tilapia supplied by the catching sector was traded at first hand by the middlemen, who distributed it to other market operators, usually wholesalers. The median volume (live weight) of tilapia traded by the middlemen interviewed was 500 t yr^{-1} (ranging from 180 to 1,825 t yr^{-1}), which indicates the larger number of medium to small size traders in this sector, typically newer entrants to the activity. The great majority of middlemen traded solely products from fisheries; only two out of the ten middlemen interviewed during the survey reported being supplied from tilapia farms, which just represented a small share of the volume traded (less than 30%). This lack of interest on trading farmed tilapia by middlemen was probably due to two main reasons; first of all, in spite of the differences highlighted earlier of each product, wholesalers and retailers traded farmed tilapia products undifferentiated from the wild products, under the generic name of tilapia or “mojarra-tilapia”, where the origin of the product (i.e. aquaculture or fisheries) was never stated; as a result, both products ended competing for the same market and resulting in lesser profits for the middlemen when trading farmed products due to their higher cost. Secondly, due to the small size of the tilapia aquaculture sector, it was difficult to be supplied constantly and in large volumes.

Middlemen were the main link of wild tilapia to the market as they were the only market operators willing to go on a daily basis (except Sundays) to the fisheries landing points, which were usually located in remote and isolated areas with difficult access, a reason why most of the middlemen were located in towns and villages near the landing points. Moreover, each middleman had an agreement (verbal only) with a group of fishermen or cooperatives, in which the fishermen would sell their catch solely to that particular middleman, and in return, the middleman would provide loans and equipment (for fishing mainly). This was particularly important for the fishermen as commonly it was almost impossible for them to get loans from banks and other sources due to their informal status (no properties, operating without permit or un-registered, and no credit history), as well as being difficult and expensive for them to reach the nearest cities to get supplies. A similar relationship was found between the middlemen and their client/business-partner, where the former agreed to supply constantly and a certain volume, in return, the latter would provide loans and/or advance payments. As a result, all middlemen worked alone as a private business receiving no support from the government.

Another key role played by some middlemen was the processing (of all or part of their produce) of fishery products to supply cheap fillets to the Mexican market, especially from fisheries on the Centre-West of the country, typically employing rustic and simple infrastructure.

Additionally, in some fisheries like “Infiernillo” (the major tilapia fishery), there were two types of middlemen, the “inland” middlemen and the “water” middlemen; while the former would collect the product at the landing point, the latter, would gather the product from the fishermen in the reservoir (in the water) to then sell it to the land middlemen. Although not all land middlemen would deal with water middlemen. This situation was found by some traders (i.e. processors and wholesalers) as excessively complicated, and normally pushing the price higher at the landing point, though for some land middlemen was more practical. That new variation of middlemen in the reservoir (the water middlemen) was created as a result of the need for faster and earlier delivery of product to the land middlemen, and for the increase pressure and competition between businesses.

Importers

As the activity importing tilapia is fairly new in Mexico (less than 10 years), there were only a few people importing tilapia products into the country as their main business (only six were interviewed during the survey), thus no official figures were available on the total number of businesses involved in this activity. However, their number had increased in the past few years due to the increasing demand of this product. The median volume (live weight) of tilapia imported by the brokers interviewed was 1,594 t yr^{-1} (ranging from 280 to 7,200 t yr^{-1}). Importers were situated in major bordering cities of the country with the USA like Matamoros, Reynosa and Nuevo Laredo in Tamaulipas, and Tijuana, Ensenada and Mexicali in Baja California. These cities were in close proximity to key US trading southern cities (i.e. Los Angeles and San Diego in California, and Huston in Texas), where a vast amount of the countries' imports are directed, and as they would be the supplier of the imported products, instead of dealing with exporters of the country of origin. However, importers would normally have their main office within the major seafood markets of the country (i.e. Mexico City, Guadalajara and Monterrey).

In some occasions, their imported goods were sold straight to their clients, without the need of storing the product, resulting in very low storing and handling costs. This situation was becoming increasingly popular among traders of imported products, to the point that few traders did not require investing in cold rooms.

The main role of the importers was perhaps, the dealing of all administrative, sanitary and legal requirements to introduce imported seafood products into the country and cross the product through the border. According to some of the importers, these processes could take a few weeks depending on how busy the place would be and how well documented the product was. After the lengthy process of crossing the border, the products were then transported to the major seafood markets. This situation made virtually impossible and too risky the importation of fresh products. If the excessive bureaucratic procedures to import products were simplified however, the industry would have seen an even greater arrival of this type of product; though, the current tendency is to create more trading barriers (i.e. requiring to state the origin of the product) and to increase its monitoring (Panorama Acuicola, 2005b). Nevertheless, the reality is that imported products are in the increase in Mexico, importers are becoming more efficient in the process of crossing-the-order of the products, resulting in many occasions, in promoting illegal and informal activities.

Processors

Although the main presentation in which tilapia was marketed in Mexico was gutted, the trade of filleted products has increased greatly in the past few years. The majority of these filleted tilapia products were still produced domestically. Apart from some of the middlemen who filleted their tilapia product before selling it to their clients (wholesalers), there were only three major commercial processors found within the whole country that processed tilapia, “Pescados de Michoacan”, “Pisimex” and “Barol”, which were processing at the moment of the study 567, 1,500 and 1,350 t yr^{-1} of tilapia respectively. All together processing more than 5% of the total tilapia produced in Mexico, but representing less than 1% of the total seafood processing plants (346 in total) registered in Mexico (INEGI, 2004). The former two were located within the centre-west and the latter on the north of the country (Michoacan, Jalisco and Sonora states respectively). Pescados de Michoacan and Barol used wild tilapia (gutted) as raw material supplied by the middlemen, while Pisimex on the other hand, imported or raised the product[20]. Additionally, Pescados de Michoacan and Pisimex processed primarily tilapia, while Barol processed other seafood products (especially squid, shrimp and flounder).

Moreover, each of these commercial processors were specialised on producing different value-added products: “Pescados the Michoacan” produced only skinned-deboned frozen tilapia fillets, packed in 1 kg trays. “Pisimex” produced mainly deep-skinned-deboned fresh and frozen fillets in 1 kg packs and branded their product with a new name, “Blanco del Nilo” (White of the Nile). “Barol” went even further, by producing skinned and deboned frozen fillets, breaded fillets, fish fingers and fish figures in 500 g packs and ceviche in cups. Furthermore, after the success of trading tilapia with a different name (i.e.

[20] This company used to be the largest tilapia farm in the country (producing around 1,500 t yr^{-1}), but due to managerial problems, their supply of the farmed product declined greatly in recent years, to compensate this lack of supply, they imported the product to satisfying their own demand.

"Blanco del Nilo"), many traders adopted the same approach, marketing tilapia with other similar names like "Blanco de Orinete" (White from the East), "Blanco Real" (Royal White), "Perca del Nilo" (Nile Perch), "Pargo Cerezo" (Cherry Snapper), etc. The first two referred to light skinned fillet (Blanco de Oriente) and deep-skinned fillet (Blanco Real). However, this strategy was perceived by some traders as deceiving and unlawful.

Nevertheless, perhaps one of the main roles played by the processors in the tilapia, trade were the promotion of the general perception of tilapia by bringing more desirable and easy-to-cook/eat presentations, and the opening of new market niches. As a result, tilapia was currently considered as an affordable seafood product of good quality, demanded not only by low income consumers, but also by the higher income population.

Wholesalers

Wholesalers played an important role in tilapia marketing in Mexico, not only by being the key link between producers (fisheries and farms), middlemen, importers and processors, with supermarkets, retailers and restaurants; but also by financing the initial stages of the marketing chain (directly middlemen and indirectly fishermen), as well as stabilising the market and balancing the demand and supply of tilapia products amongst different regions by storing large volumes of tilapia products away and selling them when domestic supplies were in decline. The median volume (live weight) of tilapia product traded by the 36 businesses interviewed was 320 t yr^{-1} (ranging from 150 to 6,800 t yr^{-1}). Although wholesalers could be found in almost all medium to large cities of the country, there were three major seafood wholesaling centres in Mexico located within the biggest cities, i.e. Mexico City, Guadalajara and Monterrey.

Tilapia commonly stands for an important share of wholesaler's trade, sometimes representing up to 80% of their income, 17% were specialised on solely trading tilapia. This was as a result of tilapia being the third seafood commodity most traded in Mexico after tuna and shrimp (CONAPESCA, 2005), where tuna is mostly traded canned in supermarkets or stores, leaving tilapia as the major fresh fish product.

All wholesaling businesses were privately owned, commonly with experience in the seafood trade (23 yr average), and most of them self financed (only 25% reported receiving or having received loans from other sources, in particular from banks). Government support was very little or unavailable. Most wholesalers were fitted with cold rooms to store the seafood products, nevertheless, the were a couple of cases in which the wholesaler did not have one, as all its product was normally sold before hand and delivered straight to the client, or in some cases the product would be delivered to its business and a few minutes later picked up by the client.

4.5.3 Tilapia retailers

As mentioned before, there were three main market operators retailing tilapia products in Mexico: supermarkets, fishmongers and restaurants/caterers.

Supermarkets

In recent years, supermarkets have become an important outlet for tilapia products in Mexico, before tilapia was typically sold to consumers only through small fishmongers in local seafood markets. In the 2004 economic census, INEGI registered 2,398 supermarkets and 18,387 mini-supermarkets in Mexico, employing 316,737 and 88,258 people respectively. Table 4.1 lists the eight major supermarket chains, their distribution within the country and the number of outlets available in 2004. The median volume of tilapia products traded (live weight) was 280 t yr^{-1} (ranging from 60 to 2,200 t yr^{-1}). Wal-Mart is the biggest supermarket chain, representing 60% of the market share for the whole sector on all products; making it the major supermarket outlet for tilapia products. However, tilapia trade varied amongst chains, for some like WalMart, HEB, and Carrefour tilapia and the seafood section were considered as profitable business; while for the rest, the seafood sector was seen as an extra service offered to the customers, thus were normally of a small size and low investment.

Additionally, supermarket chains normally had one or several collection centres where all goods were first received from the suppliers and then redistributed by them to their stores around the country. This was carried out to have a better control of the supplied goods, but also facilitated the delivery of the goods to the suppliers, allowing them to trade with larger volumes. Together with processors, supermarket chains were the only market operator to follow a quality certification scheme, where most of the chains had either ISO 9000 or HACCP. The majority of the tilapia traded by supermarket chains was imported and supplied by major wholesalers; only a few chains (4) sold wild tilapia, although it represented a small share of the tilapia traded (less than 20%). WalMart, Soriana and HEB traded mainly tilapia fillets (60%, 50% and 100% of the traded respectively), the rest preferred to trade gutted tilapia. However, the majority claimed experiencing an increasing demand of filleted products.

Table 4.2 Distribution and number of outlets of major supermarket chains in Mexico in 2004.

Supermarket Chain	Distribution	Group's Total # of Outlets	Main Branch # of Outlets
Cifra / Wal-Mart	All around the country	432	105
Grupo Gigante	All around the country	214	99
Grupo Comercial Mexicana	All around the country	158	65
Soriana	North & Central Mexico	144	
Grupo Chedraui*	South & Central Mexico	65	
Carrefour*	All around the country	29	
Casa Ley	Northwest Mexico	78	
HEB	Northeast Mexico	21	

* Chedraui took over Carrefour in 2005

Source: Websites of chains

Fishmongers

In the 2004 economic census, INEGI registered 6,558 businesses retailing seafood products in Mexico, employing 15,240 people. The median volume (live weight) of tilapia traded by the 35 businesses interviewed in Mexico was 60 t yr^{-1} (ranging from 6 to 200 t yr^{-1}). Fishmongers were the main outlet of fresh tilapia products to the final consumer. This was not only because there were nearly three times more outlets than supermarkets, but also because Mexican consumers generally perceived fish mongers as a more reliable source of fresh seafood. Additionally, the market coverage of fishmongers was greater than supermarkets, as they were found in villages, towns and cities all over the country, as well as in all sorts of neighbourhoods within the major cities, including low income areas; where low cost seafood products like tilapia, carp, mojarra and mullet were in high demand. Nevertheless, fishmongers had found fierce competition from supermarkets, mainly due to their practicality for shopping, allowing consumers to purchase all their needs in only one place, which has resulted in its high appeal particularly for medium to high income consumers.

The effectiveness of the fishmonger's network ensured that consumers' demand for tilapia products was satisfied. Most fishmongers were privately owned and in the form of stalls inside local markets. There were also few cases of businesses with several selling points and/or vertically integrated with a wholesaler. Key roles played by fishmongers in the tilapia trade were the establishment of a nationwide retailing network, to generate income for the rest of the market operators, supply different forms of fish products to consumers, and contribute to market stabilization.

Restaurant / Caterers

According to the INEGI's 2004 economic census, there were 61,902 restaurants, 179,218 fast-food and self-service restaurants, and 1,750 caterers registered in Mexico; employing 391,198, 476,905 and 32,398 people respectively. However, tilapia products were normally used only by the former (especially seafood restaurants); the remaining two types, although not well known for employing tilapia, represent a huge potential for its expansion in the Mexican market. Fast-food and self-service restaurants were normally represented by small restaurants that sell traditional or foreign dishes (i.e. tacos, empanadas, tamales, grilled or roast chicken, hamburgers and hot dogs); seafood cocktail restaurants were the most representative type within this group that employed seafood products, but normally only shellfish. Caterers on the other hand, were keener on well known marine species, which were also reliable in relation to their quality and consistent supply. However, tilapia was starting to be used by caterers and fast-food restaurants in recent years, including bars and canteens were it was used as a snack as deep-fried strings and ceviche. There had been some reports (Jorge Reyes, FIRA; Ramon Pacheco Aguilar, CIAD; Francisco Sanchez, COMEPESCA; Patricia de Debeze Murillo, COVECA; personal communication) of attempts to employ tilapia products by other foodservice sectors like schools, hospitals, jails, etc., but none were found at the time of the study.

The median volume of tilapia products traded by the restaurants interviewed (32) was 2 t yr^{-1} (ranging from 0.5 to 3.2 t yr^{-1}). Tilapia was more common to be used in restaurants located inland, especially within the centre and north of the country; whereas, in the south, tilapia was used by both, coastal and inland restaurants.

4.6 Marketing channels and product flows for tilapia products

The marketing channels of tilapia products within the Mexican market could be grouped in four major stages: production or source of the product, i.e. fisherfolk, aquaculturist and importers; businesses involved in wholesaling activities of tilapia products, i.e. middlemen, processors and wholesalers per se; businesses involved in retailing activities, i.e. supermarkets, fishmongers and restaurants; and the consumer or end-link stage, including final consumer and export.

Since the Mexican market had three main sources for tilapia products, the flows of tilapia products were divided into three types, one for wild tilapia (caught product), domestic farmed tilapia and foreign farmed tilapia as presented in Figures 4.6, 4.7 and 4.8. In reality, fish marketing channels in general and tilapia marketing channels in particular were complicated, since market operators may perform more than one marketing function. Among each type of market operator there may be an internal flow of fish products as in the case of wholesalers and retailers. In order to simplify the tilapia marketing channels, main types of flows were described, and the most predominant were highlighted. This will allow to gain a clearer understanding of the complexity of the flow for each product; and with this, highlight the apparent strategic advantage/disadvantage that each product might have in relation to the others.

4.6.1 Marketing channels for captured tilapia

The most common flow that tilapia products from the catching sector follow to reach the final consumer according to the survey is shown in Figure 4.6. As it can be appreciated, most of the catch from the fishermen was sold to the middlemen (100% median value, ranging from 40% to 100%); some fishermen reported selling some of their catch to processors, wholesalers and retailers, if they were at hand. Middlemen in turn, normally sold to wholesalers (median value 100%, ranging from 0% to 100%), although a few supplied some of the processors.

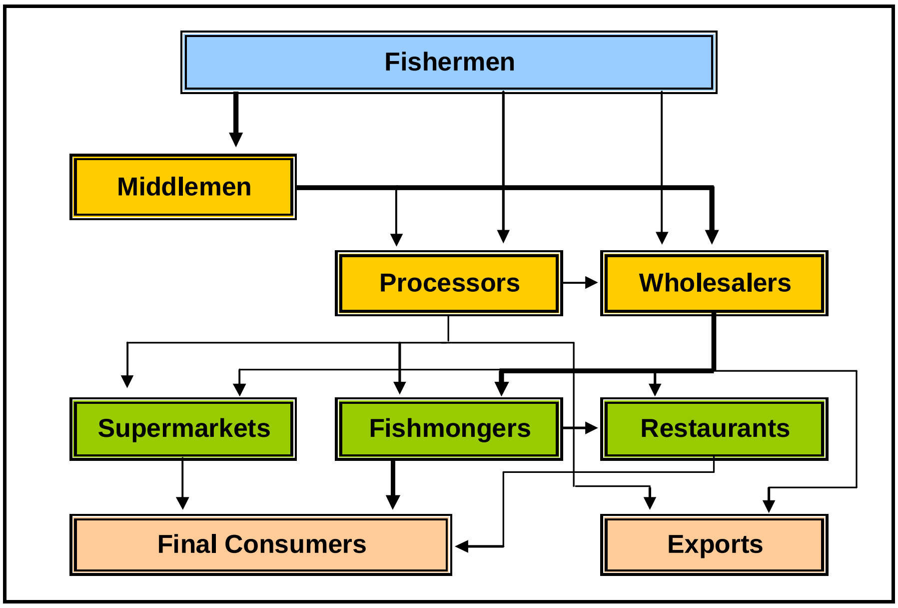

Figure 4.6 Marketing channels for capture tilapia products, highlighting the most common product flow from origin to final destination.

Consecutively most of the wild tilapia supplied by wholesalers went to all retailing operators (supermarkets median value was 100%, ranging from 50% to 100%; fishmongers median value was 100%, ranging from 0% to 100%; restaurants median value was 100%, ranging from 0% to 100%), although there were reports of wild tilapia been exported to the US by some processors and wholesalers, though the volume exported was minimal.

Nevertheless, the great majority of wild tilapia product ended at the final consumers through the fishmongers. In the context of the tilapia capture sector, such flow suggests that the domestic market played an important role in absorbing the tilapia products, becoming key for its development, compared to the export market. For the domestic market, the wholesaler was the focal point through which fish was channelled, and the fishmonger the main operator supplying wild tilapia to the consumers. Therefore, the flow from middlemen, wholesaler, fishmonger and consumers was the main channel for wild tilapia.

4.6.2 Marketing channels for domestically farmed tilapia

Farmed tilapia products flow was different compared to wild tilapia; the typical flow that farmed tilapia products followed to reach the final consumer according to the survey is shown in Figure 4.7. Tilapia farmers sold their products to two main sectors, wholesalers and directly to the final consumer (median value of 80% for the former and 30% for the latter, both ranging from 0% to 100%), although sales to the rest of the sector were also registered. The flows within wholesaling and retailing operators were similar to that from capture fisheries. Fish farming was the shortest or the most direct flow from production to consumer found within the Mexican market and the source able to supply the freshest product. Although sales to the final consumer represented the most profitable option for farmers, only small volumes were able to be traded due to the remote location of the farms and the small infrastructure available for retailing the product.

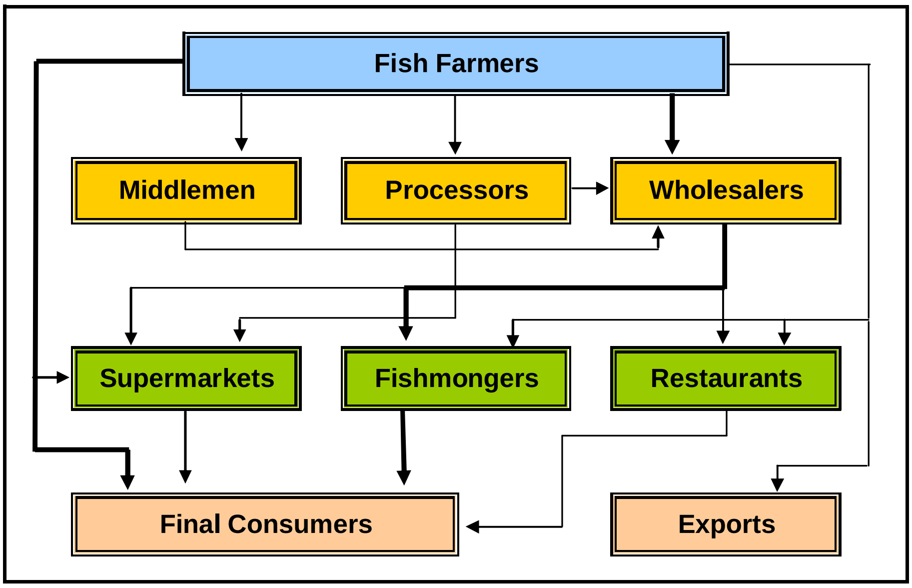

Figure 4.7 **Marketing channels for farmed tilapia products, highlighting the most common product flows from origin to final destination.**

4.6.3 Marketing channels for imported tilapia

Once in the country, imported tilapia products followed a similar flow to wild tilapia, as it can be appreciated in Figure 4.8. Although in this case, the importer replaced the middlemen, while supermarkets together with fishmongers represented the main outlets to the final consumers. However, there was increasing number of restaurants trading imported products, though commonly they would not specify their use as they claimed using only fresh products. Supermarkets were particularly inclined towards imported products due to their low cost, good presentation and practicality for handling and storing; hence the major role played by supermarkets in the introduction and promotion of this product in the country. In addition to the domestic flow, the product had to go through flows in two countries, usually China and USA. All imported products coming through USA had to be labelled, stating the origin of the product, i.e. country of precedence and production method.

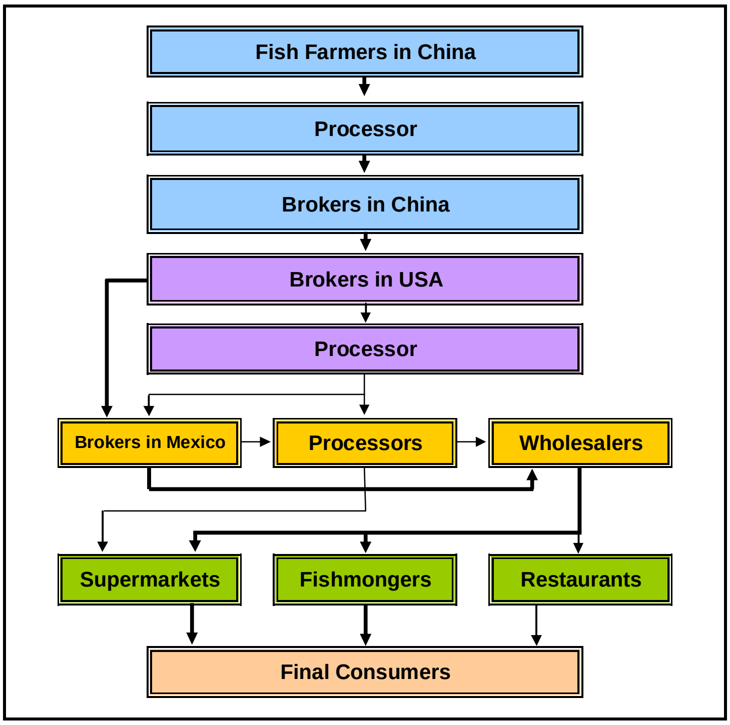

Figure 4.8 Marketing channels for imported tilapia products, highlighting the most common product flows from origin to final destination.

Perhaps the most important factor to highlight here, is that imported products showed the most complicated and by far the longest (with the largest number of marketing operators involved) marketing channel amongst sources. As a result, profits are spread amongst a larger number of operators, pushing businesses to trade larger volumes. Hence the rapid increase of the volume traded in the past decade. Additionally, although the marketing chain looked more complicated than the other sources, in reality the transactions between businesses were smoother and faster once in the country, mainly due to the practicality for handling and the consistent quality and volume supplied.

4.7 Market behaviour

4.7.1 Market share and industry concentration

Market share within the tilapia industry in Mexico was difficult to define (i.e. producers, wholesaling and retailing businesses), as many fish from the catching, farming and importing sectors were traded unreported and/or illegally, as well as prices for the same product and sector varied greatly from one place to another. However, in order to get a general picture of the market structure, the official figures for the supply of tilapia products to the Mexican market (Figure 4.1) were taken into account for the analysis of the tilapia industry concentration in Mexico, which was achieved though the calculation of the concentration ratio for the ten largest businesses (CR_{10}) (or the largest number available) within each sector (in relation to the volume traded; where the volume of the filleted product traded was translated into gutted volume as it was the most common presentation supplied by fishermen and farmers), and the Herfindahl-Hirschman Index (HHI).

According to the U.S. Department of Justice, an HHI of less than 1000 (or 0.1) represents a relatively unconcentrated market, and CR's (commonly 4) below 40% represent a very competitive industry, with a number of other firms competing, but none owning a large chunk of the market (Young and McAuley, 1994). As it can be appreciated in Table 4.3, the tilapia industry as a whole seemed to have a low level of concentration and highly competitive, when considering the total volume supplied to the Mexican market, as CR's and HHI on all sectors felt below the values previously mentioned. However, when considering the volume supplied by source (i.e. fisheries, aquaculture and imports), the result was slightly different, suggesting that the majority of the supplied from farming and imports, came from a small number of business, i.e. CR's$_{10}$ 148% and 80% respectively; and HHI 3,362 and 1,268. Additionally, the CR_{10} for wholesalers confirmed that the major businesses within the sector were the ones located in the major seafood wholesaling markets ("La Nueva Viga", Mexico City and "Mercado del Mar", Guadalajara), which were targeted on the survey. Nevertheless, these results also showed the lack of coherence between official figures and those reported in the survey, especially in the case of tilapia farming and imports; as it is believed that the survey only covered a sample of each sector, while a survey covering the whole (100%) industry would be practically impossible. In this case, resulted in an unrealistic CR_{10} of 148% for farmers; suggesting that the real volume of tilapia products traded might be well above the official figures, especially for those sources. Situation comparable to the presence of 5 farms operating for each farm registered in the state of Veracruz, as discussed by Hernandez-Mogica (2002) and Reta-Mendiola et al. (2005).

Table 4.3 Concentration Ratios (CR) and Herfindahl-Hirschman Indexes (HHI) for each market operator surveyed within the tilapia industry in Mexico.

	No of Individuals	CR_{10}* (%)		HHI**	
		Total Supply	*Supply Source*	Total Supply	*Supply Source*
Fishermen	24	0.24	*0.28*	0.01	*0.01*
Fish farmer	40	1.84	*148.24*	0.52	*3,362.40*
Middlemen	10	9.33	*10.93*	13.90	*19.07*
Importer	6	10.73	*80.30*	22.67	*1,268.73*
Processor	3	4.41		7.31	
Wholesaler	36	34.74		197.29	
Supermarket	8	4.89		8.79	
Retailer	35	1.65		0.40	
Restaurant	32	0.03		0.00	

** 10 major companies or the highest number available*

*** Based on the number of surveys*

4.7.2 Market competition

Most of the businesses interviewed in all market sectors, except for farmers, claimed not having strong competition for selling their tilapia products (above 80% on all sectors), as demand was perceived to remain the same if not slightly increasing. However, this perception could have been driven by the declining availability in the market of domestic produce for the past few years, especially from fisheries. Conversely, in many cases the respondents claimed that the competition was more for getting supplied or finding new suppliers, as many of the market operators had agreements with other operators. Farmers on the other hand, unanimously claimed finding it very difficult to compete on prices with fisheries and imports.

Competition was also found not only between tilapia products from different origin, but also with other commodities, i.e. other aquatic species and meat products. However, the perception of the commodities competing varied between operators. As shown in Figure 4.9, marine species were perceived to be the major competing commodities by the majority of the businesses in almost all sectors. Imported tilapia was perceived as the major competitor for domestic producers. Other strong competing groups were fresh water species and other meats. Major marine species defined were mainly mullet, snapper, mackerel, shark and grouper. Major fresh water species mentioned were endemic species, carp, catfish and trout. Other meats normally referred to were chicken and sometimes pork. A few businesses claimed however, that the competition with tilapia was commonly found with the fillet form only, as the gutted form had no competition whatsoever. This is perhaps because tilapia was traded before in the gutted form only, and consumers were used to buying tilapia in this presentation, resulting in high product recognition. Also, many marine species are traded in the fillet form, making it more difficult for consumers to differentiate between products, leaving the main driving force for decision, as the price and/or presentation.

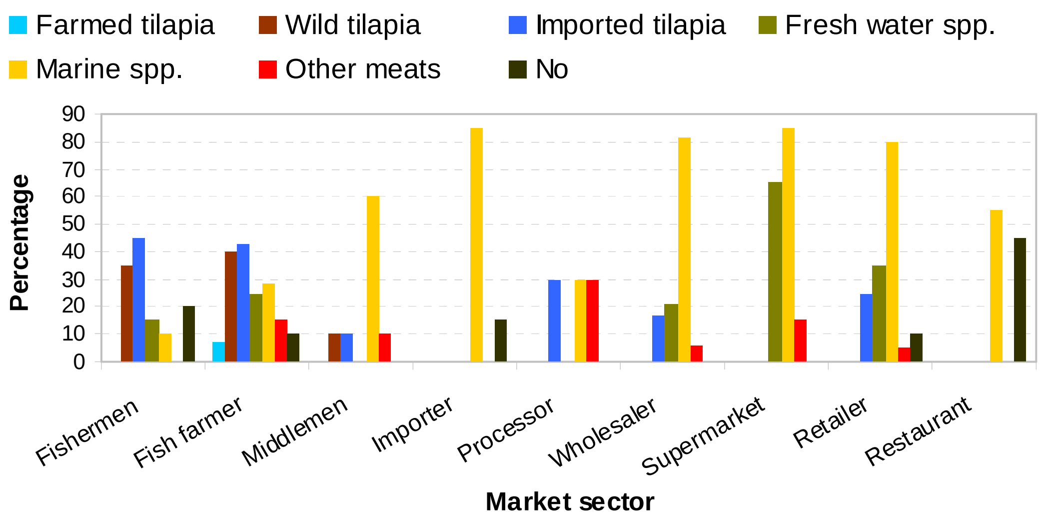

Figure 4.9 Main products competing with tilapia according to marketing operator (in percentage of businesses per sector).

4.7.3 Market prices of tilapia products in Mexico

In this section, average prices for tilapia products within the marketing chain as well as the level of profits achieved by each market operator are analysed, as well as the influence of seasonality and market operator in the price registered.

Tilapia products market prices

Prices on tilapia products, as in any other food commodity, were affected by a number of factors, i.e. market operators involved, region, presentation, demand, volume traded, supply and origin were amongst the main factors (Torres et al., 1985). Nevertheless, in order to have a general picture and a clearer understanding, average purchasing and selling prices on each market operator for the two main tilapia products traded within the Mexican Market (i.e. gutted and fillet), considering its origin (i.e. domestic or imported) were calculated. It is important to clarify that imported products were all traded frozen amongst marketing operators, with the exception of some retailing businesses and processors, who defrost the product to sell it as fresh, as it was more appealing for their clients in the case of the former and required for the process in the case of the latter. On the other hand, domestic products were normally traded fresh, although there were some wholesaling businesses (mainly wholesalers and processors) that froze the product for trading, especially when targeting other wholesalers and supermarkets, as it was considered to be more practical to handle and store.

As it can be appreciated in Figures 4.10 and 4.11, wild tilapia products were the cheapest for both presentations (i.e. gutted and filleted) when compared to other sources (i.e. farmed or imported), averaging MX$ 6.00 for gutted and MX$ 18.00 for filleted products. The former offered by the fishermen and the latter by the middlemen. Whereas gutted products were sold over 2.5 and almost 4.5 times more expensive, and filleted products almost 3 and 4 times more expensive by the importers and farmers respectively. Typical processing yield were; wild fresh gutted 85%, wild fillet 25%, frozen gutted 75%, frozen fillet 30%, farmed gutted 90% and farmed fillet 35%. This brings to light perhaps, the main factor that influences marketing operators to trade with imported products, when the catching sector fails to supply the domestic market. With exception of restaurants, farmed products were way above the purchasing price paid by the rest of the marketing operators for tilapia products. Additionally, these figures also show that the cheapest option for consumers to get tilapia products were the fishmongers, followed by the supermarket which were around 1.2 times (120%) more expensive on all tilapia products than the former, while farmed products (gutted and filleted) were 1.2 and 1.8 times more expensive respectively when compared to other fresh products. This highlights perhaps one of the greatest weaknesses for the tilapia farming industry that might need to be addressed if it wants to expand and compete in the domestic market. However, it is important to highlight that the average price for farmed products considered in this analysis was negatively influenced by the large percentage of small size operations with high production costs, while the larger businesses (e.g. > 100 t yr^{-1}) showed a lesser price disadvantage compared to other sources, in particular imported products, with reported production costs for medium (500 g) gutted tilapia of around Mx$12 kg^{-1}, compared to the Mx$16 kg^{-1} of importers selling price of the same product (but frozen).

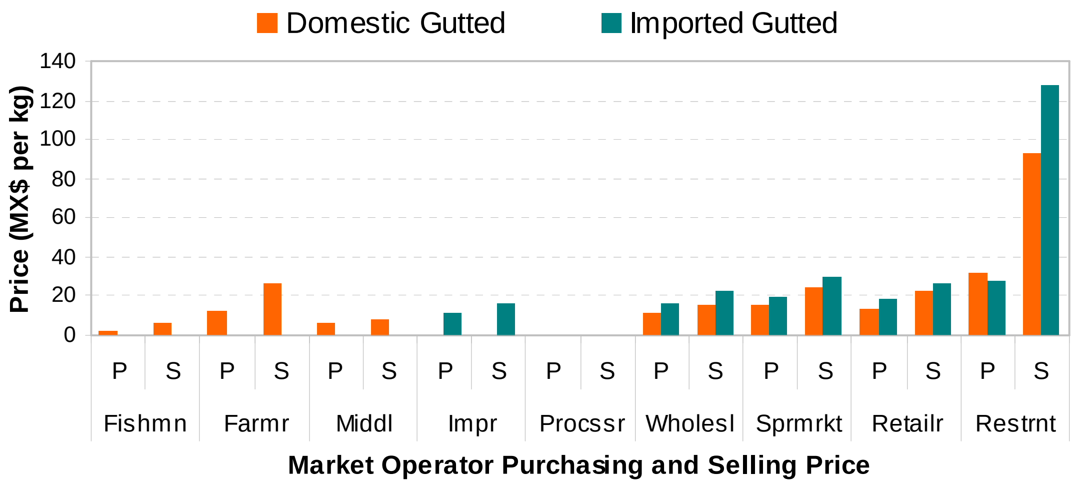

Figure 4.10 Average purchasing (P) and selling (S) price (MX$ kg^{-1}) for domestic and imported gutted tilapia products according to market operator.

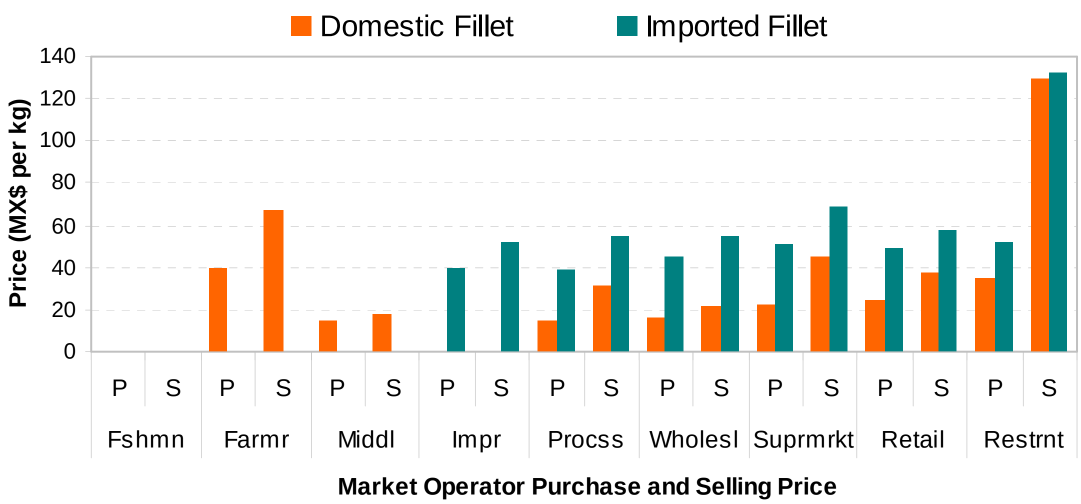

Figure 4.11 Average purchasing (P) and selling (S) price (MX$ kg^{-1}) for domestic and imported filleted tilapia products according to market operator.

Profits on tilapia products trade

In order to get a general understanding of the profits achieved by trading tilapia, the average net profit (in MX$ kg^{-1}) and profit ratio (in %) at the unit base for the two main tilapia products traded within the Mexican market (i.e. gutted and fillet) considering its origin (i.e. domestic or imported) were calculated. As it can be appreciated in Figures 4.12 and 4.13, the trade of domestic products yielded higher profits when compared to imported products for the majority of the marketing sectors (median value 20% ranging from 2% to 70%), except for gutted products in wholesalers and restaurants.

In the case of wholesalers, this was perhaps because of the presentation and packing in which imported products were supplied, which made them more appealing to their clients, thus allowing the wholesalers to sell them at slightly higher prices. However, this situation could not be repeated by supermarkets and fishmongers, as one of their aims was to provide fresh products to their customers, in order to accomplish this, sometimes they defrosted the imported products (Cipriano Pimentel Gracida, Alan Martinez, Howard Edward Bot 3rd, Rene Sanchez Franch, pers. comm.). Which in addition of the 10% weight loss when thawing the frozen products (due to the glazing layer[21]), according to many businesses the appearance of a defrosted product could never match the appearance of a fresh product, thus making them sometimes less appealing for the consumers. Suggesting that the main driving force for purchasing tilapia products for the latter, was perhaps its practicality to handle and reliability in relation to supply and quality, rather than its freshness.

The high profits of frozen gutted products in restaurants on the other hand, were probably due to the preference to employ gutted products rather than fillets in traditional Mexican

[21] Factor commonly not considered by most retailing traders when purchasing imported products.

dishes (as shown in the left picture on Figure 4.5). Larger sizes (above 500 g) would normally fetch higher prices and greater profits. Whereas domestic sources were commonly unable to supply these sizes (the catching sector due to over-fishing and bad management, and farming due to the production of smaller sizes). Nevertheless, these two factors (the demand for fresh products and in large sizes), clearly represented a window of opportunity for tilapia farming.

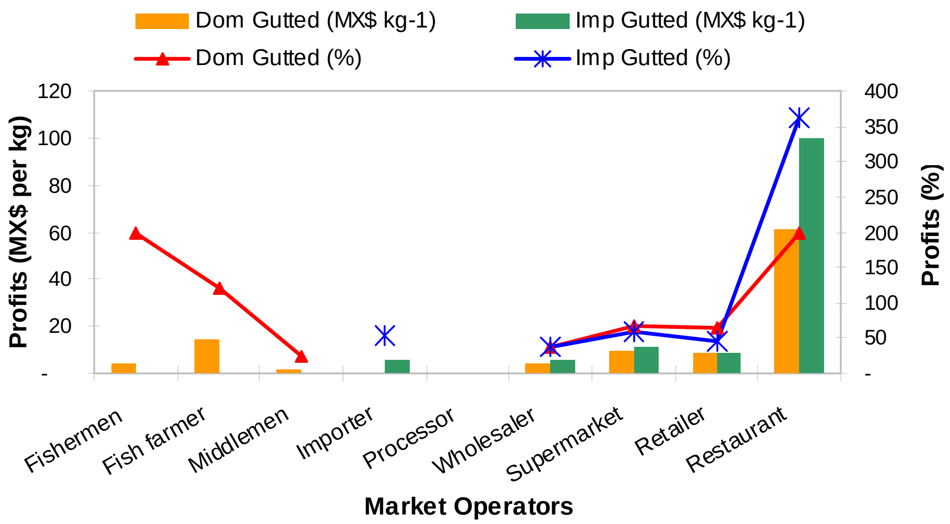

Figure 4.12 Average profit (in MX$ kg^{-1} and %) for domestic (Dom) and imported (Imp) gutted tilapia products according to market operator.

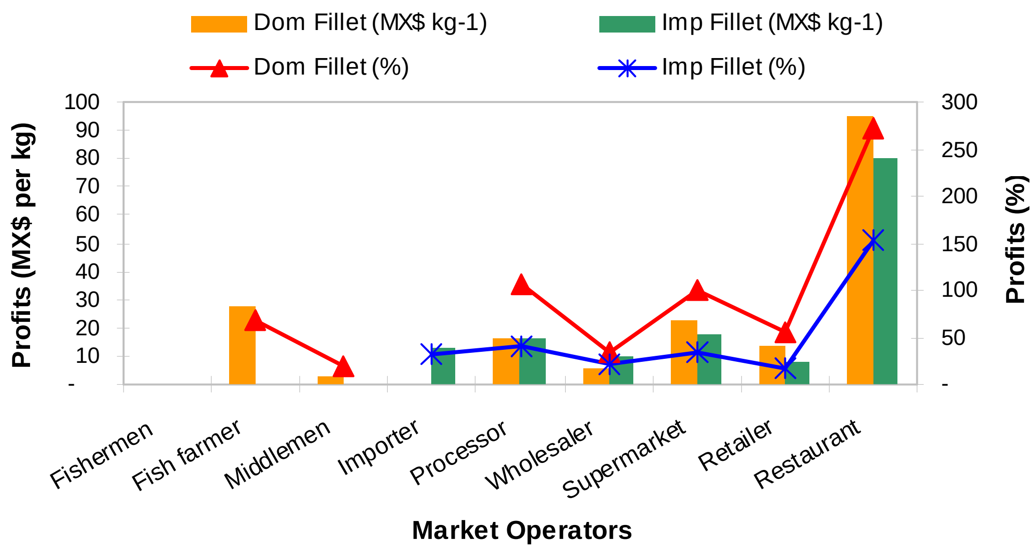

Figure 4.13 Average profit (in MX$ kg^{-1} and %) for domestic (Dom) and imported (Imp) filleted tilapia products according to market operator.

These figures also show however, contrary to the general belief, how for domestic producers (for fishermen/middlemen and fish farmers) the trade of gutted tilapia products resulted more profitable than the trade of filleted products. This was mostly related to the poor filleting processes, resulting in low yields (between 20-25%) and bad presentation (too small, with bones and pieces of skin left), thus lower prices achieved. Therefore, unless these issues are not addressed, wild products might end up been traded in the gutted form only. Nevertheless, when looking at the present market trend, fillets could represent a profitable and viable strategy to trade large volumes of raw product produced, though high quality filleting processes in their production line need to be included (i.e. no skin and bones left, uniform sizes and shapes, innocuous practices and certified). Additionally, these figures also suggest that the restaurants would be the sector most likely to accept higher prices for product supplied if quality meets their expectations and demands.

Price influence and seasonality

There were many factors affecting the price of tilapia products on demand and supply (Figure 4.14). On the supply side, tilapia prices for domestic products were affected by the periodicity of production, weather conditions which cause the seasonality of the market supply and closed seasons, especially for the catching sector. Seasonality by weather was typically found in regions located above the Tropic of Cancer (from the centre to the north of the country), which experienced subtropical extreme weather conditions, including low temperatures (sometimes near freezing), forcing fishermen and farmers to stop activities until next season. Closed seasons were defined by the government, typically during spring time, where fishing is banned in some reservoirs in order to allow the fish population to recover from the fishing pressure. Supplies of imported products were also reported by traders to experience some sort of seasonality, this happened typically during the Chinese New Year, when Chinese domestic consumption for tilapia products increases greatly.

Domestic demand on the other hand, all marketing operators' defined two main seasons, with Easter and Lent as the season with the greatest demand, and December /Christmas as the second. Both seasons as it can be noted, were related to religious traditions, which had a particular influence within the low and medium income population (above 75% of the total population of the country), who would normally preferred a cheap seafood product. The catching sector could not take advantage of this situation, as in some cases their closed season was established during spring, which is the main breeding period for wild tilapia. In other cases, the bad weather conditions prevailing during December/Christmas, forced fishermen to stop operations; a reason why some farmers (25% of the surveyed) programmed their harvest for these seasons. Nevertheless, most of the traders within the whole marketing chain claimed not having problems in selling their tilapia products at any other time of the year. Asserting that this was as a result of the good awareness and reputation of tilapia products among consumers, and perhaps more importantly, their low cost.

Many farmers (68%) reported increasing the price during high season, typically between 10% and 50%, depending on the size of the farm and the market targeted; though commercial farms normally reported the lower percentages if existent. Nevertheless, most trading sectors also reported increasing prices during high season; middlemen claimed increasing up to double the price, importers up to 30%, processors up to 35%, wholesalers'

20% average, supermarkets and fishmongers typically 30% and a few restaurants up to 25%. This situation could prove to be useful to know to producers as they could negotiate the price with their wholesaling or retailing clients to equalise profits.

In addition to the influence on price by seasonality, when the interviewees were asked which marketing operator they felt had the greatest influence in their price paid, the great majority claimed their supplier having the most influence, especially for traders. As wholesalers were an essential part of the network, normally they were pointed out as the most influencing sector by the rest. For producers on the other hand, normally were their clients, in this case also wholesalers and middlemen. This confirms the strong influence of wholesalers on the rest of the marketing operators and the important role played as market stabilisers, working as a focal point for its distribution. Also suggest the higher level of development of this sector, with businesses more economically stable, more experienced and more organised.

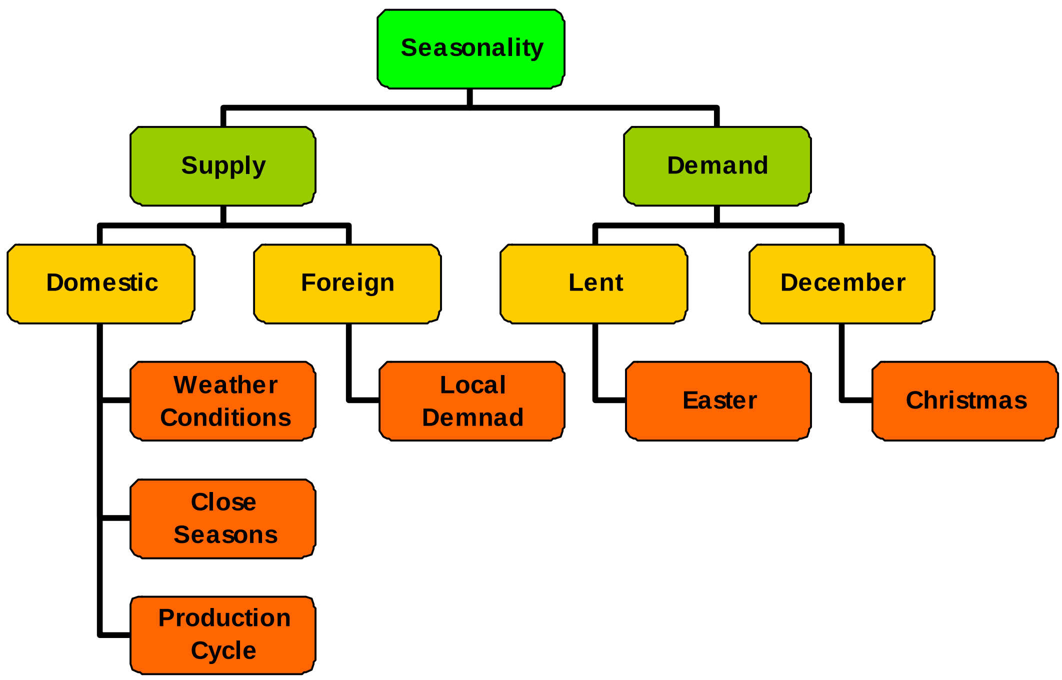

Figure 4.14 Main factors affecting the seasonality in the supply of tilapia products.

4.7.4 Marketing strategies

This section analyses the most common strategies employed by marketing operators (producers, wholesaling and retailing businesses) to promote profits. Four main marketing strategies which form part of the marketing mix (McCarthy, 2001; Waterschoot, 2000) were taken into account; product type (including gutted, filleted, fresh, frozen and other value-added products, as well as volume and consistency etc.), price (including offering lower price than competitors, flexible payment methods, discounts and promotion like two for one), promotion (including advertising in newspapers, radio, tv, etc.), and distribution (also known as place) (including market channels and geographic coverage, as well as transportation). Although in practice combinations of these elements are found within the industry, this section highlights the strategy most preferred or employed by each sector. Figure 4.15 shows the main strategy employed by marketing operators to promote profits.

Price

As it can be appreciated, price was the most popular strategy employed by the majority of the sectors. This strategy was employed as the main approach by the majority of sectors (i.e. fishermen, middlemen, importer, wholesaler, supermarkets and fishmongers), excepting fish farmers, processors and restaurants; with 45%, 50%, 83%, 50%, 75%, and 64% of the businesses respectively. Although this strategy was based mainly in offering a lower price than the competition, other approaches included discounts (e.g. bulk purchase discounts, 2 for 1, buy 1 take 1 free, etc.) and credit payments (commonly up to 1 month), the former mostly employed by supermarkets and fishmongers and the latter by producers and wholesalers. This suggests the importance of including price strategies, if planning to expand and compete with the other products and operators within the Mexican market, a situation that should be particularly considered by tilapia farmers especially when targeting wholesaling businesses.

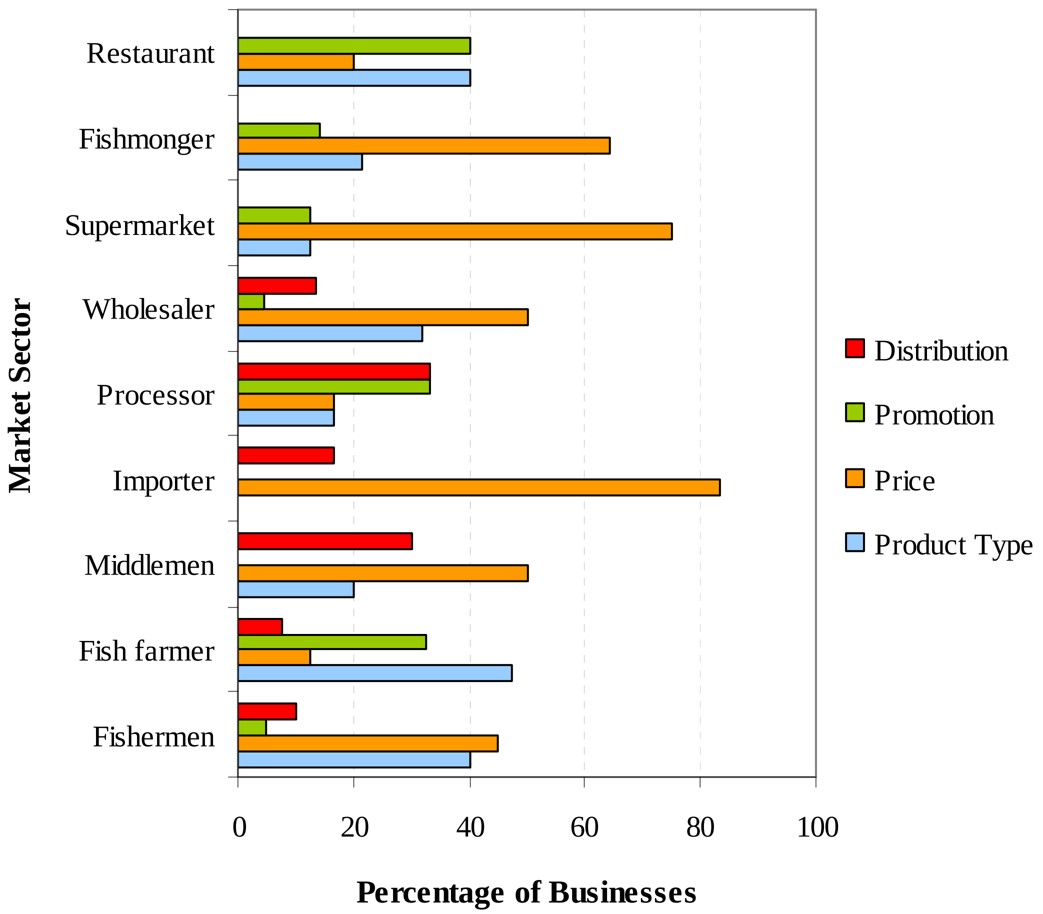

Figure 4.15 Main marketing strategies employed by tilapia producers and traders (in percentage of businesses).

Product type

Product type was the second most used strategy, typically employed by producers (fishermen and fish farmers, 40% and 48% respectively), wholesalers (32%) and restaurants (40%). Product type was the main strategy employed by farmers; typically defined not only as offering recently harvest fresh products, with excellent appearance and exempt of off flavour, diseases or parasites, but also securing volume and consistency of supply as well as selling value-added products like alive, ready-to-eat (deep fried) and fillets. For wholesalers however, this was referred as offering fresh product, size and volume consistency; while for restaurants mostly meant freshness and large sizes.

Promotion

Promotion was normally employed by fish farmers, processors and restaurants (33%, 33% and 40% respectively). Strategies varied from advertising the products mouth-to-mouth, sign posts, leaflets, newspaper and spots in local the TV and radio, to presence in social, trade and educational events (e.g. local markets, industry or trade events, congresses and exhibitions). Nevertheless, although few producers used some type of promotion (commonly sign posts and mouth-to-mouth), only very few invested in advertising their product highlighting the advantages or characteristics that could easily improve the perception of their produce, and allow them to reach more lucrative markets, i.e. Recently harvested fresh products, high standards of handling and processing, certified, healthy (free of parasites or food-borne diseases), Mexican produce and farm raised product.

Distribution (or place)

Distribution was the strategy less employed for tilapia trade. It was mostly used by middlemen and processors (30% and 33% respectively); commonly referred as delivering the product to the client. Surprisingly though, in relation to area coverage, this strategy was not perceived as important by supermarkets and retailers, as one of the focal strengths of these businesses (in particular supermarkets) are the number and distribution of outlets.

Certification

The quality scheme most commonly used within the marketing sectors was the Health Department Certification, which only certified the healthiness of fresh, chilled and frozen fish product for consumption (i.e. NOM-027-SSA1-1993[22]), but not its handling, process

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[22] The maximum levels allowed are: Aerobic Mesophilic Bacteria = 10,000,000 colonies per g; Faecal Coliforms (e.g. *E. coli*) = 400 colonies per g; *Staphylococcus aureus* = 1,000 colonies per g; *Vibrio cholerae* = Absent; *Salmonella spp* = Absent.

and management. However, as this certification scheme depended on the government only and its monitoring was commonly poor[23], thus was unreliable. The only sectors that applied different certification schemes were industrial processors and supermarkets, employing HACCP and ISO (i.e. 9000 and 14000), the former more related to processors and the latter to supermarkets. Though, the supermarkets with the best display of seafood in their stores also included HACCP (i.e. HEB and WalMart). According to Castillo (2002), HACCP is only applied in large companies but only randomly in medium to small businesses in Mexico not only in the seafood industry, but also within the rest of the agro-industries (agriculture and meat) due to the lack of proper certifying bodies, poor enforcement of the schemes and unknown costs; contrasting with the government requirements for its implementation on all seafood trade establishment (SSA, 1994a, 1994b; Secretaria de Pesca, 1995).

Most supermarkets claimed having preference for trading certified products employing these schemes, especially in the case of seafood. This suggests the importance of certification, especially if planning to target this particular sector; but also highlights the need for domestic certified products, as only imported products complied with this requirement. However, this situation could result in an advantage for farmers, as these certification schemes could be easily adopted into their operations. If certification schemes were implemented, farmed products would be able to enjoy some of the strongest characteristics of its two main competing products, the freshness of wild products locally available, and the high quality, certified and excellent presentation of imported products. With the employment of proper promotion to differentiate the product, these farmed-certified Mexican products could target more specialised and profitable market niches.

[23] Checks were usually carried out only once a year according to various market operators.

4.8 Operator's perceptions of the current tilapia marketing situation

In this section the perception of businesses on the profitability and feasibility of tilapia trade, as well as the major perceived factors hindering and promoting the development of tilapia trade were examined. At the end of the section, general views of future trends on tilapia trade were explored.

4.8.1 Perception on economic improvement through tilapia trade

Marketing operators' perception on the economic improvement through tilapia trade was examined. As shown in Figure 4.16, trading with tilapia was generally perceived by marketing operators as an important factor for economic improvement to their businesses; especially for importers, middlemen, retailers and processors. This was because of the majority of the businesses surveyed were specialised in the tilapia trade or tilapia products, thus representing a large portion of their business.

The farming sector on the other hand, reported the highest percentage of negative responses. Probably explained not only because of the large number of businesses with negative experiences[24], but mainly as a result of the majority of the businesses being either of small scale or new to the industry[25], still struggling with the learning curve and finding it difficult to cover the costs[26], even if getting some sort of support from the government. The remaining sectors with negative responses were typically due to the small share of tilapia trade in their overall income.

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[24] i.e. problems with production techniques employed, diseases, inputs costs and availability.
[25] 78% had less than 5 years of experience.
[26] Especially operational costs like feed.

Additionally, the perception of marketing operators on business performance in relation to the profitability and feasibility of trading with tilapia was also explored on businesses having other means of income or trading with other commodities. As it can be appreciated in Figure 4.17, two main situations were found; firstly, the industry as a whole, perceived trading with tilapia products as more profitable and feasible compared to other sources of income. Secondly, that tilapia was more feasible to trade than profitable; especially for supermarkets, importers, and wholesalers. This suggest an optimistic and positive view of the tilapia industry by the majority of the marketing operators; however, it also tells us of the stance of tilapia products as a commodity, perceived in general as more feasible to trade than profitable. This suggests that trading tilapia in larger volumes could represent a more lucrative business than in small scales; especially if some sort of processing is involved. The reason why farmers appear to be more negative in relation to its feasibility was normally associated to the higher price offered for their produce, thus finding it difficult to sell their product, as well as the small size (less market power) and immaturity (high percentage of unsuccessful experiences) of the tilapia aquaculture industry. Nevertheless, many of these issues could be successfully addressed through economies of scale and integration (horizontal and vertical), as suggested by Martinez et al. (2004b). Further analysis on this issue is given in the next chapter.

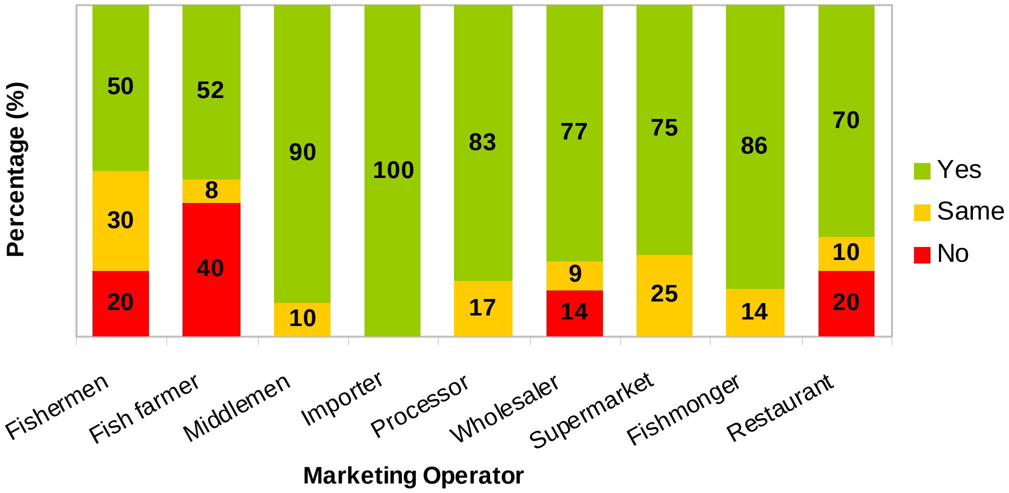

Figure 4.16 Perception of economic improvement through tilapia trade by marketing operators (in percentage of businesses claiming having improved, remained or worsen their condition).

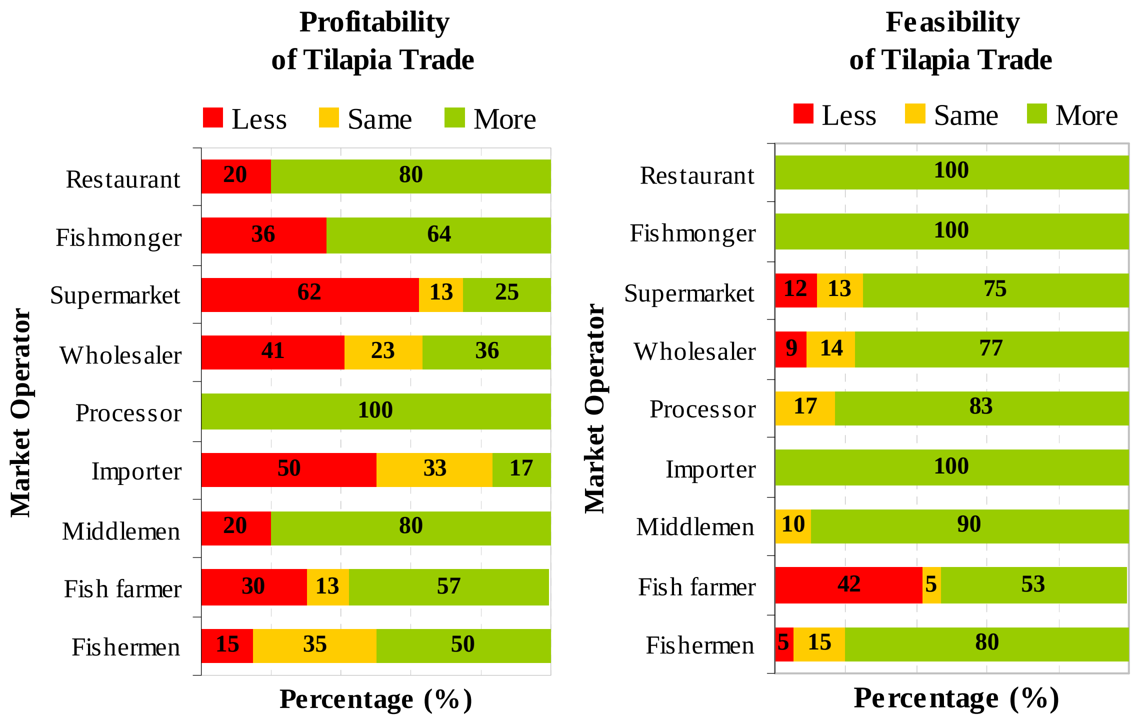

Figure 4.17 Business performance perception of tilapia trade in comparison to other economical activities by marketing operators, in relation to its profitability (left) and feasibility (right) (in percentage of businesses

claiming finding it more profitable and/or feasible, similar or less profitable and/or feasible than other activities).

4.8.2 Factors hindering tilapia trade

Factors hindering the trade of tilapia products varied in relation to market operator. Table 4.4 show the main factors reported by market operators during the survey. As it can be appreciated, the most common issues within the tilapia industry were the lack of supply of domestic products as well as its poor quality (including off-flavour, small sizes and deficient processing), imported products replacing domestic produce and trade barriers. This shows the general need for improving the perception of domestic produce, hence the potential of imported products to succeed in the Mexican market. In relation to farmers, costs of consumables, the supply of them and the unlawful competition with wild and imported products were amongst the most reported. Suggesting perhaps, the degree of immaturity in which the industry is perceived. Nevertheless, if tilapia farming manages to address its own issues, particularly its price disadvantage and small volumes, it would represent a potential source, as many of the issues described by the different marketing sectors can be easily solved through farming.

Table 4.4 Major factors hindering the development of tilapia trade according to market operators.

Fishermen	Uncontrolled fishing, low price paid by middlemen and weather.
Fish farmer	High cost of consumables (i.e. feed, electricity and water), the supply of consumables and services and market issues, i.e. price, competition from wild and imported products and the poor perception in some places.
Middlemen	Lack or over supply, off-flavour, small sizes and import
Importer	Trade barriers, tariffs, regulations and availability.
Processor	Poor quality of domestic produce, regulatory institutions and imports as main reasons.
Wholesaler	Lack of supply and poor presentation of the wild product, imported products, off-flavour and health problems related to seafood.
Supermarket	Lack of domestic supply of a good quality product, Trade barriers, dependance on imported products
Retailer	Poor quality and supply of domestic produce, off-flavour, imports and trade barriers.
Restaurant	Increasing prices, poor quality of domestic produce and imported products.

4.8.3 Main factors promoting tilapia trade

Factors promoting or improving the development of tilapia trade were also different amongst marketing operators. The main factors reported by marketing operators are shown in Table 4.5. As it can be appreciated, the most common factors defined by the businesses surveyed were the improved quality, value-added products, improved presentation and perception, increased demand and low prices. Nevertheless, it was also mentioned that at the beginning, when trade of tilapia products first started, was the availability of fresh product in large quantities and very low price. In recent times however, the introduction of imported products has helped to improve the perception of tilapia products, stabilise the supply, thus the price, and reach new market niches. In relation to farming, the acquisition of new technology and proper management seemed to be the major factors, which in many cases helped to reduce production costs. As it can be seen, not much was said about trade or marketing of their products from them, indicating that this is the area less considered within the sector; which considering the previous discussions, perhaps this is one of the most delicate issues that the aquaculture industry needs to address.

Table 4.5 Major factors promoting the development of tilapia trade according to market operators.

Fishermen	Proper management and support from government and middlemen
Fish farmer	Establishment of proper protocols, new strains, adecuate infrastructure and equipment available, proper water quality and reproduction management.
Middlemen	Quality of product supplied, filleting, increased demand and perception of tilapia products.
Importer	Constant availability, high quality, presentation and packing of imported products
Processor	Profitability and increasing demand for value-added products.
Wholesaler	Excelent presentation of imported products, increased demand, better quality of products supplied, better perception of tilapia products, low prices and value-added products, fresh products available through farming.
Supermarket	Size and quality consistancy, imported products, value-added products, information and low prices.
Retailer	Improved perception, increased demand, better presentations and prices, service, promotion and farming.
Restaurant	Good quality and low prices

4.9 Conclusions

As marketing was believed to be an important part of the development of the tilapia industry in Mexico, the research discussed and analysed several key issues; from which the following can be concluded:

Declining outputs of tilapia from fisheries and stagnant growth of aquaculture have allowed imported tilapia products to become in a short time, the second most important source of tilapia products for the Mexican market. Better quality and packing, availability in constant and large volumes and low prices, have resulted in increasing demand of these products by many market operators, in particular supermarkets.

Mexico presented a regionalised demand for tilapia products; the north and west of the country preferred fillets, whereas the centre, east and south preferred gutted products. Condition that was driven mainly by the activities adapted on major fisheries from those areas. According to traders (Martin Quezada, 2003, personal comm.), this was as a result of the small size of the product catch (on major fisheries in the west and north), having to fillet the product in order to speed sales, claiming that a filleted product would sale faster than a gutted product of that size. Nevertheless, fresh fillets of larger sizes were also in demand but scarce in supply, and being replaced by defrosted imported products; similar to gutted products demand on the centre and south of the country. This clearly represents a window of opportunity for tilapia farmers, as clearly larger sizes and fresh products are more difficult to be supplied by those two major sources.

In addition to the previously said, the more complicated and larger marketing channels of fishery and imported products should place farmed products in strategic advantage, especially for those niche markets requiring fresh products, where quality and constant supply can be reassured. However, larger profits can be achieved as long as products are marketed though the shortest channels. This would require a lot of marketing research (to find key markets) and organisation (to deliver the product) by commercial producers.

When considering the total volume of tilapia supplied to the Mexican market, the tilapia industry as a whole seemed to be unconcentrated and highly competitive. However, when considering the volume supplied by source, the result was slightly different, the majority of the supplied from farming and imports came from a small number of businesses, thus concentrated and with little competition from other businesses. Nevertheless, the lack of coherence between official figures and those reported in the survey, especially in the case of tilapia farming and imports, suggested that the real volume of tilapia products traded might be well above the official figures.

Competition was found mainly between tilapia products of different sources and other aquatic species and meat products. For the former, farmed products find strong competition from much cheaper wild tilapia and more appealing imported products. However, competition was also found between tilapia and other white meats, especially marine species like mullet, snapper and mackerel; and to a lesser extent, with meat products like chicken and pork; although the latter (competition with white meats) was mainly related to filleted products. In the first case (farmed vs. wild vs. imported) was mostly as a result of the trade of tilapia products undifferentiated from its source (i.e. without stating if the products was farmed, wild or imported), from wholesalers to the rest of the marketing chain; while the in second case (tilapia vs. white meats), according to traders (Cesar Berbardo & Jose Siordia, 2003, personal comm.), when buying fillets, consumers look more for the appearance of the product (e.g. colour, freshness, packing, display, shape, etc.) rather than the specie itself, as most products would look similar. Additionally, an increasing number of large retailing businesses (especially supermarkets and restaurant chains) were becoming keener on products certified by independent bodies, i.e. ISO and HACCP. However, at present the only source able to deliver this requirement were the imported products, another important factor that has influenced its success in the Mexican market.

Tilapia was sold by many farmers at higher prices than the ones paid by the rest of the marketing operators, mostly as a result of its higher production costs. Price difference averaged four times more than its cheapest competitor (wild products). This highlights one of the main issues that the aquaculture industry needs to tackle if it pretends to compete with the other sources. The research also found that the sector that would be more willing to pay premium prices for high quality fresh products would be the restaurants; therefore it could represent a key strategy to achieve better prices. Additionally, gutted and fillet fresh products in large sizes proved to fetch high profits and be in high demand by many retailing businesses, particularly restaurants; where neither the catching sector nor imports were able to supply.

The tilapia market in Mexico is strongly influenced by various factors inducing seasonality in both, the supply and demand of the product. However, the most important season to consider by far is Easter and Lent, when prices increase in average up to 30% in most marketing sectors.

In the overall picture of the industry, tilapia trade was considered as a profitable and feasible business by most marketing operators; however, tilapia farmers were the only sector with the highest negative perception, though this was most probably influenced by the generalised poor perception of the industry driven by its immaturity, slow development and large number of unsuccessful experiences. Suggesting the need for development and support schemes focused on driving the industry into a more competitive level.

Nevertheless, tilapia trade was considered as more feasible than profitable compared to other economical activities by the majority of the marketing operators, suggesting that in order to secure a profitable business, large volumes would be required to be traded.

4.10 Future trends on tilapia marketing in Mexico

After considering the previously mentioned, several situations can be expected to happen in relation to the marketing of tilapia in Mexico. First of all, supply is expected to rise rapidly in the short to medium term, as outputs from all three sources are expected to rise. In the case of the catching sector, some of the major fisheries seem to recover, thanks to the employment of good fishing practices. Similarly, the aquaculture sector at last appears to be taking off, as more business can be seen from both sectors, private and social. A situation that is expected to continue, as development, support and financing institutions seem to be more involved and perception of the activity seem to improve among businesses. Additionally, more value-added products might be seen coming out from this sector, as production costs remain a major issue for the industry, forcing businesses to look for more specialised and profitable markets. Imported products however, will be the fastest growing supply source, expected to increase greatly within the short term as many marketing operators seemed to be keen and feel more comfortable with these products. Both presentation are expected to be demanded, gutted products mostly by wholesaling sectors like processors and wholesalers for further processing, and fillets by retailing sectors.

Domestic demand is also expected to increase as awareness of tilapia products reaches more people from wider economic backgrounds through the availability of more value-added products, and improved presentation and perception of these products. In contrast to the traditional way tilapia is consumed in many parts of the country, an increase in demand of tilapia fillets can be expected by consumers as current trends in the domestic markets demand more products, which are easy to prepare when consumed at home (i.e. ready-to-cook and ready-to-eat), versatile to cook (suitable for more dishes) and practical to eat, especially when consumed away from home (i.e. restaurants).

Exports of tilapia product from Mexico are also expected to rise, as domestic production and process of imported products will continue to increase. Jorge Reyes from FIRA defined five main routes or regional markets defined as axes of trade (Figure 4.18). Base on one major domestic market, conformed by the Mexico City – Guadalajara Axis; three main routes targeting the US market, i.e. California – Arizona Axis, Texas Axe and Florida Axis; and one for Europe. Exports to Europe could be supplied from two main air freight locations or hubs, Mexico City and Cancun, which have direct flights to many major cities in Europe. US axes were defined due to being the largest populations of Latino ethnic minorities within the US.

Figure 4.18 Domestic and export market for tilapia products, by major axes and rotes (Adapted from Reyes, 2003).

Furthermore, farmers are expected to target more retailing marketing operators, and less wholesaling, as were the sectors more able to afford paying premium prices for high quality products. Competition will remain the same between tilapia products (i.e. wild, farmed and imported) and other species, as it will still be competing with other white-meat fish. Additionally, the only tilapia product that can be expected to reduce its price from the source, are farmed products, as there are still plenty of issues that could help bring down the costs; whereas the other two sources, if not remaining similar, will increase due to the unorganised and complicated marketing channels followed.

The following chapter (Chapter 5) will explore the role played by development, support and financial institutions as well as strategic partnerships in the development of the tilapia industry, especially in the case of the aquaculture sector.

Chapter 5 The business environment in the tilapia industry

5.1 Background

Mexico is a complex society which requires the interaction of millions of individuals and hundreds of thousands of organisations to provide it with the products and services which it needs to exist. The environment in which these individuals and organisations work has to be suitable to ensure that the nation makes the most efficient use of its resources, both natural and manufactured (Callaghan, et al 1982; and Farnham, 1995). The business environment in Mexico has evolved into an intricate and dynamic entity, involving the independent actions of a multiplicity of people, undertaking a host of tasks. Tilapia farming, as in any other economic activity in Mexico, is also influenced by a great array of external factors. Figure 5.1 shows the diverse inter-institutional coordination and interactions of agri-business in the Mexican economy. This shows first hand interaction with government institutions involved in regulation, support, development, education and research, and interactions at a second level with private, legal, trade, production and financial associations or centres. This also highlights the key role that the government may have in the development of national agri-business, and the increasing role to be taken by the strengthened private sector.

Tilapia farming, similar to other economic activities, not only relies on its production and market for its development, but also depends on various external factors (Morales, 1991; Pillay, 1994; Spreij, 2005). The purpose of this chapter is to gain a better understanding of the major external factors and constraints that hinder the development of the tilapia aquaculture industry in Mexico, particularly related to the industry's business organisation, regulation, promotion/development and financing. The goal is to highlight the means to promote its development, and address its constraints.

To gain a clearer understanding of the situation regarding the development context, the research explored and assessed the current development of the business organisation of the sector, presenting case studies of successful operations to describe the potential these organisations have in the development of the sector. Additionally, this chapter also assessed the current strategies and attitudes of key institutions involved in regulation, development and support, and financing of the tilapia aquaculture and fisheries industry, its processing and trade; and analysed its performance and constraints within major players of the industry. Description of the categories of institutions/organisations/businesses targeted by the study and the number of people interviewed were described in Chapter 2.

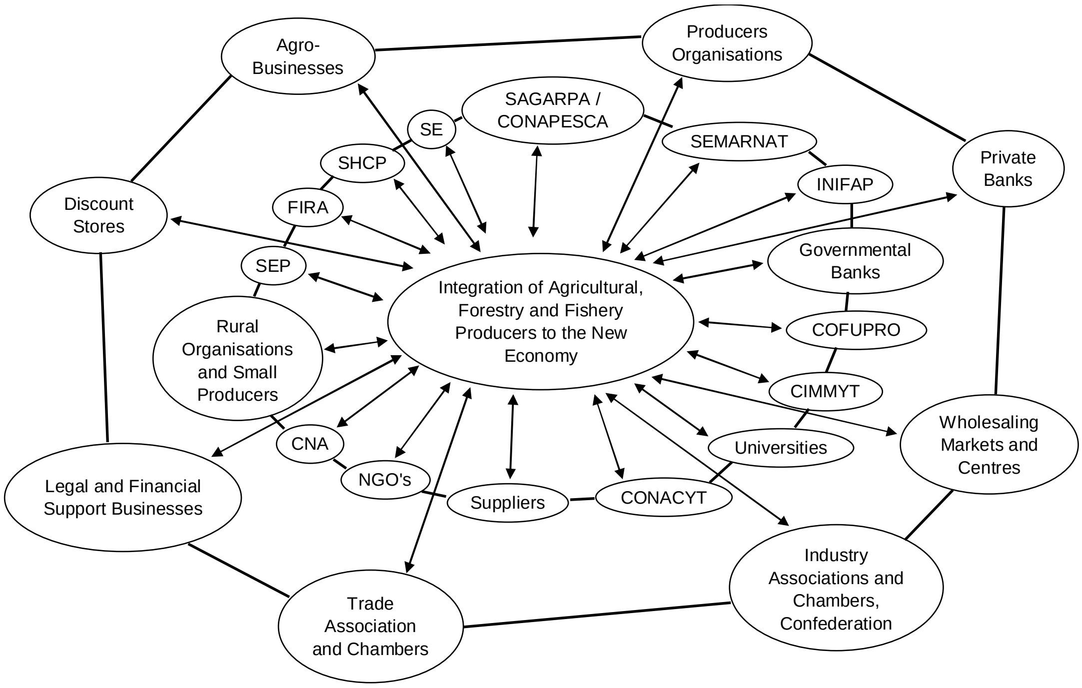

Figure 5.1 Inter-institutional coordination for agro-businesses in the new economy in Mexico (Adapted from Reyes, 2003).

5.2 Tilapia sector businesses organisation

5.2.1 Types of organisations

As for any other business sector, individuals tend to use the organisational structures which offer them the most advantages. Because fish farming is such a diverse business activity, no single structure can meet the needs of individuals or for all situations. Regardless of size however, all farms are a form of business and can be organised or structured in several ways, whether is sole proprietorship, partnerships or corporations (Kohler, 1993). In the tilapia sector sole proprietorship and partnerships, are currently the most common types of business organisations (40% and 60% respectively of the businesses interviewed). The major advantage of sole proprietorship is full control of the business, while for partnerships more resources can be brought to the businesses by members. The major disadvantage for the former is the full liability status, while for the latter is loss of full control. Appendixes 8 and 9 describe the main advantages and disadvantages.

5.2.2 Current situation in Mexico

In 2001 the sector registered a total of 16,313 enterprises (private, fisheries cooperatives, fishing societies and fishing unions among others), of which 1,275 were registered for commercial aquaculture (SAGARPA, 2003). There were two main aquaculture stakeholders; the private sector composed of wealthier investors, and the social sector, including agrarian reform communities, communal organisations or production cooperatives which are mainly comprised of resource-poor individuals. The main component of the social sector is the "ejido" an organisation established by the state. Most aquaculture farms are held by the social sector (de Walt et al., 2002), and the majority of the tilapia farmers interviewed in the research where of a small scale (less than 100 t yr^{-1}). Private businesses were normally organised as sole proprietorships, while the social sector in cooperatives.

5.2.3 Successful case studies

Some of the main strategies proposed for a successful industry according to CONAPESCA (2003), were the fortification of the organisational mechanisms between the producers, their capacity to deal with suppliers, agri-industries or dealers; as well as the improvement of their production directed to the new needs of the consumer. To assess the current situation and examine possible areas of development the study aimed to identify best examples currently active on both sectors (private and social), of small to medium size tilapia businesses that had developed and succeed through industry integration, partnerships, and diversification.

Vertical Integration and Branding

Perhaps one of the most successful operations involved in tilapia farming that Mexico has seen was “Pisimex”. Although this company had access to plentiful economical and technological support, managed to produce the largest outputs the country has ever seen (around 1000 t yr^{-1}) in 2002. More importantly though, was the fact that they processed their own product (filleting) and created their own brand, naming tilapia differently (“Blanco del Nilo”) to avoid association with the popularly known “mojarra-tilapia” from the fisheries. Strategy that allowed them to achieve higher prices and market niches (i.e. supermarkets). The company employed economies of scale based on high-technology cage farming at a reservoir in the Centre-West of the country (Jalisco State), processing plant and marketing and sales departments. Unfortunately, this company experience serious operational problems (massive-kill due to reservoir inversion), stop producing and switched into importing tilapia, processing it and marketing it the same way.

Vertical-Horizontal Integration and Partnership

There were two successful examples in business integration and partnerships at the time of the study, one with tilapia and one with catfish. The tilapia case (Biotecnologias Acuicolas SCP & Algimex), was based in the southeast (i.e. Campeche, Quintana Roo and Yucatan states). The business was vertically and horizontally integrated, accounting for a feed plant, hatchery, grow out facilities, and commercialization centre. This was the only business showing partnership between cooperatives (social sector) and private producers. According to Monroy and Carrillo (2004, pers. comm.), the success of the business was due to been able to produce their own feed at much lower cost, and supply directly to key markets like supermarkets, avoiding middlemen and wholesalers, thus reducing the high costs of feed and eliminating profit loss through large marketing chain.

The second case (Acumex), was a highly successful partnership located in the northeast (Tamaulipas and Nuevo Leon States), were a group of mid-size (100-200 t yr^{-1}) catfish farmers decided to join efforts after realising that they were driving each other out of business through intense competition (Carlos Jauregui, 2003, pers. comm.). At the time of the study, the business was the largest catfish producer in the country and was the only one fitted with processing plant and commercialisation centre for this type of product. It was also the only one exporting its product to the US (100 t yr^{-1} approx.) and producing fingerlings in mass scale (8 million yr^{-1} approx.), supplying many regions of the country. According to Jauregui, Benavides and Etienne (2003, pers. comm.), the success of this company was first of all mainly due to the elimination of direct competition and economies of scale, and secondly due to the vertical integration in which allowed them to specialise on each activity, increasing efficiency and further reducing production costs.

Integration and Diversification

Two cases highlighted for their success. The first (Desarrollo Basilio Vadillo) was a project developed in a reservoir in the state of Jalisco for sustainable production of tilapia through fisheries and aquaculture, as well as for training and research purposes; expecting to expand into eco-tourism in the near future. The success of the project was based on close partnership with support and development institutions, the social sector and regional sustainable development.

The second case was located in the state of Sinaloa, where a cooperative of fishermen (Cooperativa Pesquera El Salto), decided to expand their wealth though diversifying and expanding into aquaculture. Not only they were one of the most successful and best managed fisheries in the country, but also an example to other fishermen on how to develop a sustainable industry. They also integrated vertically by developing their own inputs supply centre and trade office.

5.3 Regulation of the tilapia industry in Mexico

5.3.1 Introduction

Various governmental institutions, at Federal, State and Municipal level, are responsible for regulating and monitoring activities in production, processing and trade of tilapia products. The main federal institutions and the core regulatory framework, are described in Table 5.1. State and municipal governments also regulate and promote regional and local fisheries and aquaculture through their Fisheries Departments. However, poor management of fisheries and the slow development of aquaculture have been attributed in particular to poor monitoring, inspection and surveillance (Alvarez-Torres et al., 1999, 2003; Garcia-Calderon et al., 2002; Perez-Velazquez et al., 2002; Spreij, 2005). These especially concern the lack of a solid, trained, modern, honest and active structure; favouring illegal fishing and generalised law breaking from producers, and compromising the sustainability of the fisheries and aquaculture in Mexico.

5.3.2 Regulation of tilapia production

Regulations and institutions involved

Since 2001, SAGARPA has been in charge of administering the fisheries and aquaculture legislation, replacing SEMARNAP (Ministry of Environment, Natural Resources and Fisheries). According to the Fisheries Law, tasks and responsibilities of SAGARPA include - *inter alia* - the designation of areas suitable for aquaculture, regulation of the introduction of species and the promotion of aquaculture development. CONAPESCA, an administrative entity of SAGARPA, was created in 2001 and is responsible for management, coordination and policy development regarding the sustainable use and exploitation of fisheries and aquatic resources. The Commission has the support of the National Fisheries Institute, also an administrative entity of SAGARPA, which conducts scientific and technological investigations and gives advice on the preservation, restocking, promotion, cultivation and developing of aquatic species (Spreij, 2005).

The Fisheries Law (Ley de Pesca) and its Regulation are the main legislative documents governing the conservation, preservation, exploitation and management of all aquatic flora and fauna. The Fisheries Law was amended in 2001, and the Regulation in 2004. In addition, various Official Mexican Standards (Normas Oficiales Mexicanas - NOMs) facilitate the implementation of the Fisheries Law by detailing requirements as to the conduct of activities within and development of fisheries and aquaculture. Generally, NOMs are specific measures and standards required by law, which are proposed by the various administrative Secretariats in their corresponding area of jurisdiction and issued by the Federal Executive (Spreij, 2005).

Table 5.1 Main federal institutions implicated in the regulation of all activities involved in the tilapia industry.

Abreviation	Definition	Description
SAGARPA	Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food	Regulates, monitors and enforce all issues related to the exploitation and usage of ***natural resources***
CONAPESCA	Aquaculture and Fisheries National Commission	Regulates, monitors and support all issues related to ***fisheries and aquaculture*** . Depends on SAGARPA.
CNA	National Water Commission	Regulates and monitores all issues related to ***water usage*** .
SEMARNAT	Ministry of Environment and Natural Resources	Regulates and monitores all issues related to ***environment protection*** .
PROFEPA	Federal Attorney General for Environmental Protection	***Enforce environmental laws*** , regulations and environmental NOMs. Autonomous entity under SEMARNAT.
SSA	Ministry of Health	Regulates and monitores all issues related to ***human health*** .
SE	Ministry of Economy	Regulates and monitores some issues related to ***trade*** (i.e. labelling).

Constraints

Most NOMs developed for fisheries are case specific, designed to regulate a particular water body in relation to its specific geographical, hydrological, economical, social and biological conditions. The majority were developed only for fisheries with declining outputs, which could represent major ecological, economical or social problems for the region; thus there are only a few regulations targeting new fisheries and aquaculture activities. However, declining outputs of tilapia are widespread in most of the country, out of the 26 most important tilapia fisheries in Mexico (five in rivers, four in lakes and seventeen in reservoirs), only six fisheries have been regulated and a further five are in project (Table 5.2).

The tilapia aquaculture industry has arisen in many places without adequate regulation and support, without effective NGOs to serve as intermediaries, and without ways for communities to monitor and evaluate resource use and impacts. Legislation of aquaculture businesses in Mexico is complex, voluminous and fragmented among numerous enactments, and sometimes governed by a number of overlapping laws and regulations that fall under the jurisdiction of different agencies. Table 5.3 summarises the various regulations, legal requirements and governmental institutions involved in the different activities implicated in setting up an aquaculture business. A list of NOMs regulating fisheries and aquaculture, relevant to tilapia production is provided in Appendix 10. So far, excluding shrimp farming, only three NOMs (including one projected) specifically regulate aquaculture. Regulations focus mainly on issues regarding importation of live aquatic organisms and implementation of HACCP in aquaculture businesses (projected). The only species with specific regulations are shrimp (i.e. diseases and feed control) and tuna (i.e. labelling).

Table 5.2 Major water bodies with important tilapia fisheries regulated by the Mexican government (SAGARPA, 2004b; CONAPESCA, 2005).

Water Body Type	Name (Common)	No Regulated	Regulated *Published*	Regulated *Project*	NOM
Rivers	Grijalva-Usumacinta			X	PROY-NOM-037-PESC-2004
	Papaloapan	X			
	Coatzacoalcos	X			
	Balsas	X			
	Panuco		X		NOM-033-PESC-2003
Lakes	Chapala		X		NOM-032-PESC-2003
	Cuitzeo	X			
	Patzcuaro	X			
	Catemaco			X	PROY-NOM-041-PESC-2004
Reservoirs	El Novillo	X			
	El Oviachic	X			
	El Humaya	X			
	El Mahone	X			
	Huites		X		NOM-025-PESC-1999
	El Comedero	X			
	Bacurato	X			
	El Salto	X			
	Las Adjuntas		X		NOM-024-PESC-1999
	Las Animas	X			
	Falcon			X	PROY-NOM-042-2003
	Aguamilpa		X		NOM-026-PESC-1999
	Chilatan	X			
	Infiernillo		X		NOM-027-PESC-2000
	Temascal	X			
	La Angostura			X	ANTEPROY-NOM-039-PESC-2001
	Malpaso			X	ANTEPROY-NOM-038-PESC-2002
Total		***15***	***6***	***5***	

Table 5.3 Legal procedures required for the planning and operation of aquaculture facilities, and trade of seafood products.

Phase	Activity	Requirement	Institutions involved	Regulations involved
Planning	Usege of federal water bodies	Concessions (commerical purposes), permits (exploratory and promotional purposes) and authorizations (educational purposes) for aquaculture purposes.	CONAPESCA	Fisheries Law, Environmental Law
	Access to land and water	Land ownership (private, ejido and federal lands), water usage and discharge concessions and permits and ecological zoning plans.	CNA, SAGARPA, SEMARNAT, State Governments and Municipal Authorities	Mexican Cosntitution (Article 27), General Law of National Property, Regulation for the use and exploitation of the territorial sea, navigable waters, beaches, federal maritime zones and lands gained from the sea, National Water Law
	EIA (Environmental Impact Assessment)	Required in the case of works and activities that may cause ecological imbalances or surpass the limits and conditions established in the applicable provisions to protect the environment and preserve and restore ecosystems. Requires a preventive report prior the EIA.	SEMARNAT and State Governments	General Law of Ecological Equilibrium and Environmental Protection Regarding Environmental Impact Assessment
	Foreign ownership	Trust set up required for foreign ownership of aquaculture production, processing and marketing facilities	DGIE representative from SE and CNIE	Foreign Investment Law and National Foreign Investment Registry
Operation	Water and Wastewater	Prevention and control of water pollution, discharge permit,	CNA, SEMARNAT, State Governments and Municipal Authorities	National Water Law, NOMs, National Water Plan,
	Fish movement	Authorization for the introduction of living species in federal water bodies; Aquatic health certificate; Disease and genetic history records study for imported species; Genome impact of introduced species; Technical study addressing the biology and habits of the species to be introduced; Possible effects of introduction of exotic species on native flora and fauna study.	CONAPESCA, CONABIO and CIBIOGEM representatives from SAGARPA and SEMARNAT	Fisheries Law
	Disease control	Health certificate required for farming, movement, introduction to other water bodies, export, import and capture of wild populations for aquaculture. Certification and registration of quarantine establishments.	SENASICA and CONAPESCA, belonging to SAGARPA	Federal Animal Health Law, Fisheries Law,
	Drugs	Human health and soil pollution prevention and control provisions,through licensing, registration and permitting of any use, development, manufacture, distribution, storage, commercialization, export or import of chemical substances.	CICOPLAFEST, representative from SAGARPA, SEMARNAT and SSA	General Health Law, Environmental Law
	Feed	Types of feeds and additives authorisation, (only for shrimp culture).	SAGARPA	NOM-EM-006-PESC-2004
Trade	Food Safety	All fish and seafood products, whether fresh, frozen or preserved, must meet food safety regulations	SSA	General Health Law, and NOMs: 027-032, 128 and 129-SSA
	Fixed establishments	Hygienic and health practices requirements in the preparation of food offered on fixed establishments.	SSA	NOM-093-SSA

Industry perception

A large percentage of tilapia producers interviewed (64% of fishermen and 57% of fish farmers) claimed to find some regulations hindering development of their business. While for fishermen main constraints were more related to enforcement of closed seasons and quotas, fish farmers reported a number of issues including, the complexity of the legal system (33%), excessive tariffs and permits (30%), strict environmental regulations (23%), lack of protocols for fish farming management (10%), and free entry of imported products (3%). Bureaucratic issues were normally referred as excessive paper work, difficult to understand, too many institutions involved and time consuming. Tariffs and permit issues, as the higher electricity, land and water usage tariffs and permits required for aquaculture compared to agriculture or livestock. Environmental issues, as the complex and costly environmental impact studies required when registering the project with SAGARPA.

Spreij-FAO (2005) also highlighted the complexity of many of these issues, including the use and ownership of land and water for aquaculture purposes, tariffs and permits, environmental impact assessment (EIA), fish movement, diseases, feed and chemical controls.

5.3.3 Regulation of tilapia processing

Regulations and institutions involved

A small number of policies are involved in seafood processing, regulating key aspects of the industry including, the implementation of high quality and certified processes (e.g. HACCP), the display of health specifications of fresh and frozen, preserved and dried-salted fish products, hermetically packed and thermically treated food, and the operation of hygienic practices. The Ministry of Health (SSA) is responsible for the monitoring and enforcement of these policies. The most relevant regulations involved are listed in Appendix 11.

Businesses perception and constraints

Only a minority of businesses interviewed processing tilapia claimed having issues with the regulation (30%). However, most complaints related to policies involved in supply of wild product, unrelated to the activity itself, i.e. close seasons and minimum size of products from the catching sector. Other important issues were the large numbers of institutions involved in similar issues (bureaucracy), the lack of enforcement to display a certification of origin for imported products (unlawful competition from businesses trading imported products) and the labour law (too difficult to fire an irresponsible staff member). In general, well established processing plants did not have real problems with any regulations and normally would operate within the law, as one of their main clients, the supermarkets, required high standards on the products purchased to trade, and certified products were highly demanded. Informal processors on the other hand (e.g. market traders), were less likely to follow HACCP standards, or any other regulations; situations that although allowed them to keep costs low, clearly compromised the quality of the product and the industry itself. These businesses were more likely to be in isolated areas and unregistered, making monitoring difficult by regulatory bodies.

5.3.4 Regulation of tilapia trade

Regulations and institutions involved

Trade of food products in general and seafood products in particular, are regulated by a wide array of policies. These NOMs focus on three main issues, labelling, the information provided and protocols; which included values and contents, nutritional specifications, origin of the product, sell-by and best-consumed-before dates, methods and specifications for the monitoring of pathogens and substances in food products, and hygienic and health practices on fixed establishments. The main NOMs regarding trade of food in general and seafood in particular are listed in Appendix 12. Labelling and information required on food products traded are monitored and enforced by the Ministry of Economy (SE); while pathogens, substances and hygienic practices are monitored by the Ministry of Health

(SSA). Only one NOM was species-specific, designed for trade of tuna (NOM-084-SCFI-1994), which regulated the commercial and health information required, including origin.

Businesses perception and constraints

The perception of policies regulating food trading varied amongst sectors; while most traders and importers interviewed (60% and 85% respectively) claimed having issues with some of the regulations, only a few businesses in the other sectors (i.e. wholesalers, supermarkets, fishmongers and restaurants) had issues (only 20% average). However, issues reported were similar across the sector; highlighting complex requirements and bureaucratic procedures, excessive tariffs for imported products (other than NAFTA) and lack of regular or constant monitoring by governmental institutions, usually present only during high season.

5.4 Promotion and support of the tilapia industry in Mexico

5.4.1 Introduction

Promotion and support to the aquaculture industry is provided by a number of institutions and organisations, mainly belonging to the government. Promotion programs aim to generate greater awareness of the activity and further expand the industry, while support programs provide existing businesses with tools and resources to improve efficiency and further continue their existence. These institutions are involved in various activities for industry development, i.e. regulation, financing, technology transfer, research and education, industry coordination and promotion.

However, until recently, development programs focused only on promoting the production sector of the industry, neglecting the need for its coordination with the other sectors of the industry chain, i.e. processors and traders. Development programs had been defined for three main production categories; rural (i.e. social sector), restocking (i.e. fisheries) and industrial (i.e. commercial farming) aquaculture (Morales, 1991; SAGARPA, 2001).

However, most efforts had been directed to the first two categories due to their potentially greater impact for the rural population.

Promotion and support schemes to the sector are normally provided in three main forms: financial (i.e. money), technical (i.e. research, consultancy or courses) or in kind (i.e. materials, equipment or consumables); or a combination of them. The former mostly related to promote the industry, while the last two were mostly involved in supporting the industry. This section will focus on these last two forms (i.e. technical and in kind support), as the financial support will be discussed in more detail in the following section.

5.4.2 Support institutions and their programs

Sectoral institutional leadership in Mexico currently stems from the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA). Other institutions related to the sector can be found at the local, municipal and state level, including the academic and productive sectors. Two government bodies are directly related to aquaculture, the National Commission for Aquaculture and Fisheries (CONAPESCA) dependent on SAGARPA, while Ministry level scientific support is provided at the National Fisheries Institute (INP). They cover all sector administrative, technical and scientific needs (Alvarez-Torres, 2003). CONAPESCA lists five major programs for aquaculture and fishery development: Technological Training and Assistance, Construction and Fortification of Value Webs, "Alianza Contigo"-Aquaculture and Fishery Program, Rural Aquaculture National Support Program and Aquatic Health National Program; which are further described in Appendix 13. Other important organisations involved in the development of agri-businesses were ASERCA, FIRA, PAASIFIR, SIAP, SENASICA, and SEDESOL; a further description can be found in Appendix 14. Various institutions and programs were involved in development of agribusinesses, covering the different demands and requirement of the industry. Most of these institutions also provide financing support, only two had more specific objectives and type of support provided, i.e. information and health monitoring and research (SIAP and SENASICA).

5.4.3 Education and research institutions

The main public sector organisation to promote and support activities in science and technology is the National Council of Science and Technology (CONACYT). Among its various functions there is the National System of Researchers (SNI) whose main objective is to fortify and encourage the efficiency and quality of research in all fields including aquaculture (OCDE/Education). CONACYT also establishes links with international organisations responsible for scientific research and technological development. However, an evaluation (1998) by OECD and the World Bank stated that despite substantive advances in the creation of infrastructure in scientific areas, mainly in the academic sector, there are clear signs of weakness in technological areas (OECD, 2002).

This situation may be difficult to understand considering the number of research and educational institutions involved in development of aquaculture in Mexico. Some of the key institutions involved in tilapia research are listed in Appendix 15. Most of their efforts at the time of this study were focused on genetic improvement (e.g. colour, growth and sex reversal), feeds (e.g. replacing fishmeal), production systems (e.g. low cost systems), value-added products (e.g. surimi, fish fingers and packing), integration and polycultures (e.g. with shrimp, native species, livestock and agriculture), technology transfer, diseases (i.e. gnatostomiasis and parasites) and environment (e.g. sustainable farming).

Most efforts were focused on production development and very little on marketing and trading issues, a common issue in many countries (Young et al., 2000); and which as described in previous chapters, are the most crucial issues for the sector.

5.4.4 Main issues related to development institutions

The purpose of development and research institutions and programs was to contribute in improving the rural population's quality of life through promotion improvements in production technology, and fortifying opportunities for investment, market access and finance. However, in analysing these programs, results and impact have not been as expected. In most cases these programs have been hampered by common institutional problems related to governmental organisations, such as the lack of coordination between different institutions, excessive bureaucracy, different legal framework imposed on every new government elected, high concentrations of support on a few producers, insufficient and delayed funding schemes, lack of experience of extension staff, information difficult to reach, use of the resources for political purposes, and others (Gomez et al., 1999; Leon, 1999; Reyes, 2003a).

Results of this study show that development programs have reached only the production sector, as almost none of the businesses involved in processing and trade of tilapia products interviewed, claimed receiving any form of support from the government. The only types of support received in three wholesaling businesses were the promotion of seafood consumption, courses and consultancy, but the impact on their businesses was claimed to be limited or not yet realisable. On the other hand, almost two thirds of the producers interviewed reported receiving some form of support (Figure 5.3); amongst the more common were consultancy (37.5%), economic (35%), in kind (25%) and promotion (7.5%). Support to the production sector was mainly given to producers belonging to the social sector or small private businesses. Medium to large businesses normally did not get any support.

The reasons reported by both sub-sectors (production and trade) for not getting support were similar, i.e. not been required, not aware of them, no information available and too difficult to access (i.e. excessive requirements and bureaucracy); the former being the most common within trading businesses. This shows first that the main priority of development institutions is the production sector and the development of agribusinesses. However, they have failed to cover the industry as a whole, where producers, traders and development institutions should work in coordination for an integrated development of the industry.

Nevertheless, a more recent development program from SAGARPA (2001) seemed to address this issue through the promotion of value webs and production chains, although it might take some time before some beneficial results are seen. Further information of the latest development program can be found in Appendix 16. Another major issue is the apparent isolation of research institutions from industry, with very few cases of research findings being employed by producing, processing and trading businesses. This suggests the poor performance of development institutions to bridge the wealth of knowledge from research institutions and the production sector; and conversely, allow the research institutions to clearly understand the requirements of the production sector. However, this issue seemed to be covered in the recent development program (Technological Training and Assistance), though it was too soon to discuss its impact on the industry.

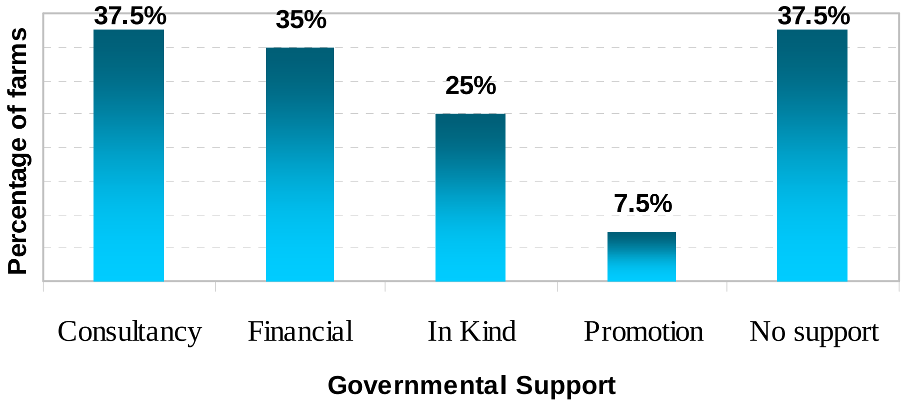

Figure 5.2 Types of support given by governmental institutions to tilapia farmers interviewed.

5.5 Financing of the tilapia industry in Mexico

5.5.1 Introduction

Mexico's agricultural programs reflect the heterogeneity of its agricultural sector. Producers range from large commercial operations to small, subsistence-oriented farms. Accordingly, some Mexican farm programs are geared more for advanced commercial operations, others are designed to advance less developed operations, and still others are available to virtually all producers. In many instances, programs are designed to address perceived gaps and bottlenecks in the agricultural economy, particularly in agricultural finance (ERS-USDA, 2004). The aquaculture industry in Mexico was first stimulated by the 1992 changes to the fisheries and land tenure laws. Since then, a variety of investment sources have assisted in the expansion of the industry, i.e. private, national banks and financial institutions (de Walt et al., 2002).

5.5.2 Financial sources

Government sources

In the social sector, government sources of credit have been critical for its development, with various institutions and organisations involved. Apart from the institutions mentioned earlier, also involved in the financing of agribusinesses, i.e. ASERCA, PAASFIR, FIRA and SEDESOL, other main sources of credit were: BANCOMEXT, FINRURAL, FOCIR, and FONAES. Further information on the major institutions and organisations involved can be found in Appendix 17.

The Bank of Mexico (BANXICO) through FIRA has increasingly provided funds and credit for the aquaculture sector with a share of 54.4% (US$ 129 million) of credit provided to aquaculture projects in year 2000 (Alvarez, P. 2003). Since 1999, FIRA has pursued a new business model that considers the financial needs of the entire food system, including some non-agricultural activities in rural areas. To accomplish this task, FIRA had developed new products, such as structured financial instruments and inventory financing. It also fostered a wider distribution network for funds that includes non-bank lending institutions called Limited-Purpose Financial Societies (Sociedades Financieras de Objeto Limitado - SOFOLES), financial leasing companies, and warehouse companies. FIRA also provided agribusiness consulting and sector-specialized information and analysis (ERS-USDA, 2005).

Other important development banks were the National Bank for Foreign Commerce (BANCOMEXT), a Mexican governmental institution in charge of export promotion and the attraction of foreign investment; which has funded some operations in the social sector. Another important governmental institution in agricultural finance is Financiera Rural.

This new entity replaces the Banco Nacional de Crédito Rural (BANRURAL), which was dissolved on June 30, 2003. Financiera Rural's primary mission is to make loans to agricultural producers and rural financial intermediaries, to facilitate capacity building among producers, and to foster the development of rural financial intermediaries. However, unlike BANRURAL, Financiera Rural is not a retail bank offering savings accounts, but disburses funds through branches of affiliated banks. It also operates programs to distribute credit through other entities and to facilitate contract agriculture (Alvarez, 2003).

Among the main trusts and funding organisations for economic development are; the Capitalisation Fund for Rural Investment (FOCIR), which has a special program for the development of aquaculture; and the National Fund to Support Solidarity Enterprises (Fundo Nacional de Apoyo para las Empresas de Solidaridad - FONAES), designed to provide support for productive activities that will benefit people who live in extreme poverty (de Walt, 2002; Alvarez, 2003).

Perhaps the major rural development program is the "Alianza Contigo" (Alliance with You), which accounts for almost a fifth (18%) of SAGARPA's 2004 budget. Formerly known as the Alianza para el Campo (Alliance for the Countryside), Alianza Contigo encompasses a broad range of extension-like activities. Some examples include: providing grants and technical assistance to producer groups and organisations for improvements to farm and ranch operations and cooperative ventures in production, storage, and marketing; supporting agricultural mechanisation and technical improvements; helping marginal producers to switch to more productive activities; financing research, development, and technology transfers to improve the supply chains of specific commodities; and promoting food safety and the achievement of sanitary standards.

Private sources

Currently, private banks in Mexico provide loans for aquaculture; however, interest rates are considered to be prohibitive. Banks charge annual rates of interest at about 45% (de

Walt, 2002; Alvarez-Torres, 2003), as the activity is considered as high risk. However, annual rate of inflation has reduced from 29.9% in 1990 to 8.9% in 2000 and 3.3% in 2005 (Banco de Mexico, 2006), closer to rates registered in developed countries (e.g. between 2 and 3%). Among the more commonly used for loans for aquaculture are BANCOMER-BBVA, SANTANDER-SERFIN, HSBC (formerly BITAL), BANAMEX-CITIBANK, BANORTE (the only remaining 100% Mexican Bank). Therefore, probably the largest amount of investment in aquaculture has come from other private sources:

~ Individuals with capital to invest, often, families that had accumulated wealth though farming or livestock.

~ Participation associations between a private producer and a cooperative/ejido sector community.

~ Corporate sources of support, where the major suppliers and marketers also provide credit to producers.

~ Small companies that pool the investments of several shareholders.

~ Joint ventures with foreign companies.

Another substantial source of private investment that is difficult to quantify is drug money, which is laundered through legitimate businesses; although, for obvious reasons, not much probing about this source of financing can be carried out (de Walt, 2002). This is particularly common in shrimp farming; where a great number of businesses are located within conflict zones, i.e. in northwest and near the borders.

5.5.3 Main issues related to the financing of the tilapia industry

Governmental financing to fish farming had represented only a small proportion of their budget to the fishery sector (which includes aquaculture), ranging from 0.1 to 1.7% of their annual expending between 1994 and 2003 (CONAPESCA, 2003). The major beneficiaries have been shellfish farmers (mainly shrimp) (from 24%-54% of the budget), processing businesses (17%-52%), and more recently, coastal and inland fisheries (6%-23%). The budget for marketing activities had remained the same within that period (3%-9%) (Figure 5.3).

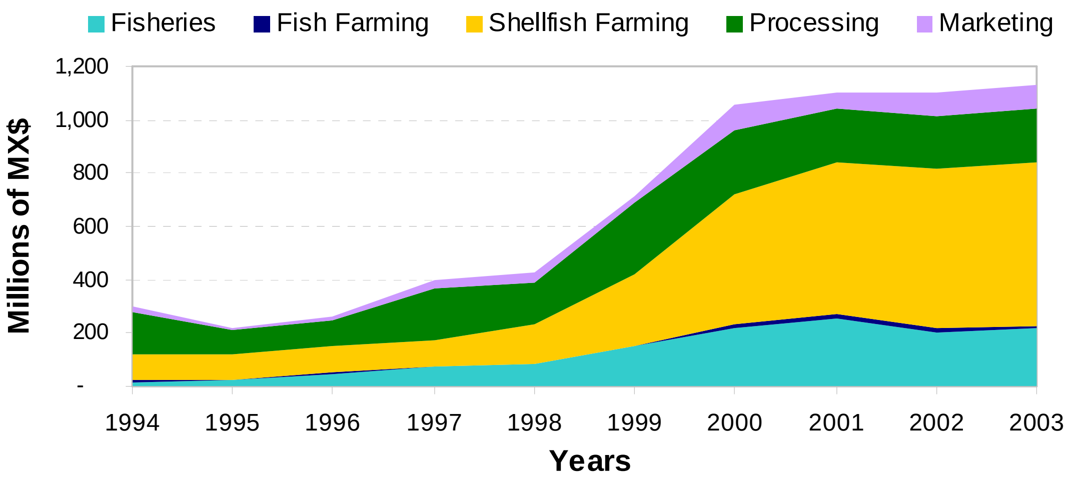

Figure 5.3 Financing given (millions of MX$) to coastal and inland fishery, fish farming, shellfish farming, processing and marketing by FIRA-FOPESCA between 1994-2003 (CONAPESCA, 2003)

The study suggested that financing through governmental institutions represented 40% of the businesses interviewed (fully and partially), while private banks only 3% (Figure 5.4). According to farmers, the main reasons they could or did not get loans from private banks were the excessive guarantees required (60% of businesses), high interest (58%) and bureaucracy (35%) (Figure 5.5). However, considering that the main source of finance was through the producers' own resources (nearly 50%), the small size of the industry, and the large number of development institutions and programs available, raises questions of the performance and interest or efforts of these institutions towards the tilapia industry.

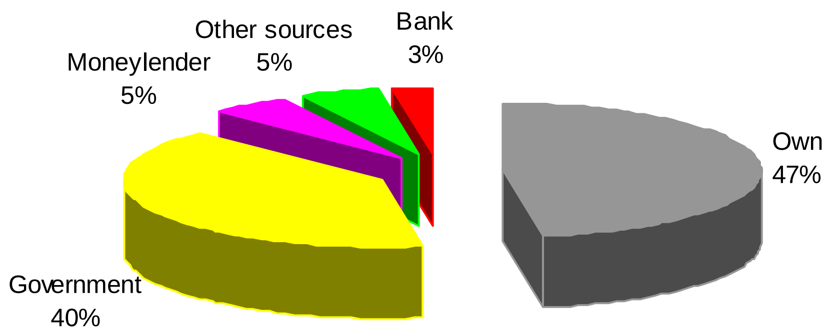

Figure 5.4 Source of financing for tilapia farmers in Mexico.

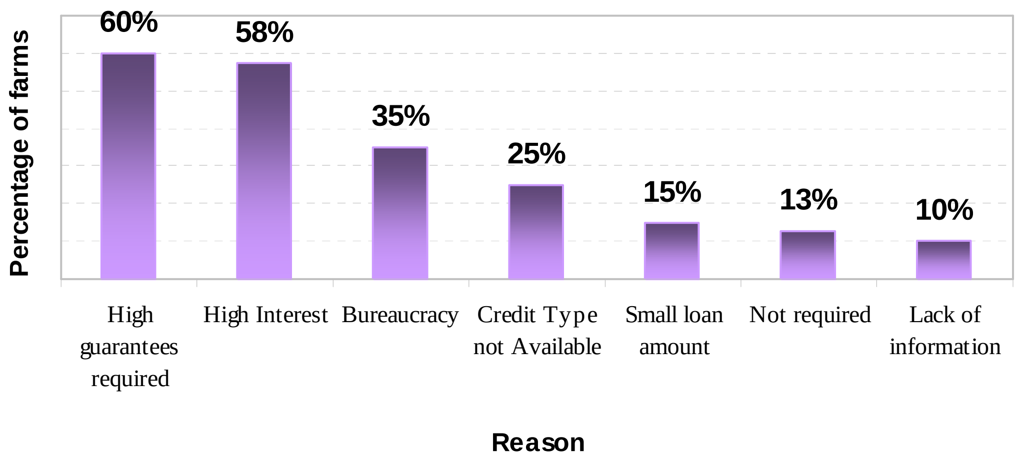

Figure 5.5 Main reasons for not dealing with private banks by tilapia farmers.

On the other hand, most of the trading sectors employed their own resources, excepting wholesalers and retailers, where 30% of the businesses interviewed on both sectors were financed at some point by private banks. According to Reyes (2003a), one of the main problems that governmental institutions face, apart from the excessive bureaucracy, is the constant changing of the legal and organisational framework of the institutions; impeding the proper monitoring of their performance. Also, as public sector support had been easier to obtain, an increasing number of businesses had become comfortably dependent on them, requiring frequently more subsidies to solve their problems instead of becoming self-sufficient and economically viable.

However, the latest development program from SAGARPA (Appendix 16), has tried to address this issue by promoting a culture of business sense on new projects, replacing their focus on subsistence aquaculture only. Additionally, many of the development programs have been designed to reduce the negative perception of the aquaculture industry by sharing the risk of the projects and absorbing some of the losses in a worst case scenario. However, their impacts on private banks policies have not yielded any positive results yet as interest rates still prohibitive.

Other issues to note from the study have been the poor availability of information and promotion of the programs available, where most of the farmers and businesses interviewed had very little if any idea of the development programs. This suggests the need to develop programs which are more user-friendly, allowing people with different backgrounds to understand them. Additionally, the common use of financing for political purposes requires a closer monitoring of institutions and individuals in charge of their distribution. Overall financing through governmental institutions has been significant and seems to cover all main areas of the industry. Arguably this has filled gaps in support from private banks in agribusiness, or businesses in the sector, or alternatively has removed much of the need for alternative financing. Most importantly it appears in some cases to have removed important aspects of commercial discipline and project realism.

5.6 Conclusions and further development

5.6.1 Business organisation

Hazell (2004) mentioned that small aquaculture farms always have a disadvantage in the market place. They only trade in small volumes, often have variable and substandard quality products to sell, lack market information, and have few links with buyers in the marketing chain. These inefficiencies can all too easily offset the efficiency advantages of small farms as producers. The problem may be exacerbated by market liberation and globalisation. Not only has the state been removed from providing many direct marketing and service functions to small farms, leaving a vacuum that the private sector has yet to fill in many countries (Kerallah et al., 2002), but small farmers must now also compete in ever more integrated and consumer-driven markets where quality and price are everything (Narayanan et al., 2003). Small farmers will need to organise themselves to overcome these problems and to exploit the new opportunities that these market changes offer; otherwise they risk losing market access.

The private food sector is emerging as a key player in linking larger-scale commercial farmers with markets (e.g. contract farming and supermarkets), but they have less interest and ability to deal with small-scale farmers on an individual basis. Voluntary producer organisations of various types will have important roles to play in filling this void and in linking small farmers to food processors, manufacturers, traders, supermarkets, and other food outlets (Kindness et al., 2002). Such organisations can help serve businesses by providing an efficient conduit to reach small-scale producers and help improve the quality and timeliness of small farmers' production and their access to aquacultural research and extension, input supplies, aquacultural credit.

Partnerships were more common within producers belonging to the social sector, with very few cases of private associations. However, the most successful producers found during the study involved operations employing some sort of business organisation strategies, i.e. horizontal/vertical integration and partnerships. With joint efforts, shared risks, organisation and economies of scale, businesses managed to achieve profitability in viability, and able to compete with major sources (fisheries and imports). The small number of partnerships within the private sector was most probably as a result of the common negative attitude of farmers towards sharing experiences and information, and reluctant to form associations.

Nevertheless, unless producers are able to invest large amounts for business expansion and economies of scale, association in partnerships seemed to be the most successful and viable strategy for SMEs to compete in major markets. Unless just interested in targeting their local market for live and fresh products. The resent government development programs seemed to be focusing in this issue through their "value webs", in which efforts have been made to bring closer producers, traders and input suppliers. Therefore, it is expected to see more associations and partnerships in the short term.

5.6.2 Tilapia industry regulation

SAGARPAS's 2001-06 aquaculture and fisheries sector program focused on three major regulatory issues: to establish public policies for sustainable exploitation of fishery and aquaculture resources; to offer and promote legal certainty in the fishery and aquaculture sectors; and to regulate fishery and aquaculture legislation under the principles of sustainability and responsible fishing. The strategies and projects defined by CONAPESCA and INP to achieve these objectives can be found in Appendix 18.

As it can be appreciated from Table 5.3, most policies regulating activities involved in production of aquatic species in general and tilapia in particular through aquaculture, focused on environmental issues. Although this shows the interest and effort by government to develop a sustainable industry, this overlooks other key aspects of the industry, such as human health and management protocol issues, i.e. regulation of drugs and chemicals used for aquaculture and implementation of HACCP (still projected). Many such aspects have already been addressed successfully by developed countries like neighbouring USA, where some of their regulations could be easily adapted to Mexico. However, some development has been made by SAGARPA and SE to tackle key issues within the shrimp farming and tuna trade, i.e. the prevention and management of viral disease problems and labelling – approaches which could also be adapted to species like tilapia.

The regulation of processing and trading seafood products on the other hand, were focused on human health aspects; portraying the effort from the government to reassure a healthy and hygienic food supply in the country, a particularly sensitive issue when dealing with any seafood product.

The main concerns amongst businesses within the tilapia industry in relation to regulations were more related to institutional performance and costs involved in complying with policies, i.e. the complicated bureaucratic procedures, excessive tariffs and permit costs and lack of monitoring. These factors when combined with the negative perception of governmental institutions (i.e. being uninterested and too costly to approach), caused many businesses to operate informally, especially micro scale and small businesses.

An efficient regulatory environment provides certainty to the industry, the government and communities to plan for future growth and expected impacts, addressing issues such as whether, where and how it will grow, as well as maximising benefits to rural and regional areas. Nevertheless, entrepreneurs complain of unpredictability as governmental institutions and their programs and regulations have varied greatly from one presidential period to another. Yet reforms in Mexico are rare, a common situation in developing countries (Spreij, 2005). The country has faced the same issues concerning laws and regulations for decades.

The difficulties businesses work against come from a lack of information and from discretion in enforcement. Thus only a few businesses comply with the regulations, since it is so prohibitively costly and complicated, so many entrepreneurs choose to operate in the informal economy.

Although due to the sensitiveness of the issue interviewees were reluctant to expand in this issue, it was estimated that less than 30% of producers and around 55% of traders complied with regulations. The low percentage found on producers was as a result of the lack of enforcement of these regulations, as businesses typically were more difficult to reach. A large informal sector is bad for the economy: it creates distortions, reduces tax revenues and excludes many people from basic protections. If regulation were simplified and constantly up-dated to tackle rising problems, entrepreneurs would find benefits in moving to the formal sector, such as greater access to credit and to courts. However, increasing number of newer entrants into the industry (particularly in production), with the aim of developing mainly industrial-scale commercial operations, and many planning to export, have resulted in growing numbers of producers investing more efforts in up-dating their legal status and following all regulations. Proportion of law-abiding businesses has also been boosted by a more active regulatory government within the past few years.

Although for many producers the industry seemed to have excessive regulations, especially for the catching sector, there were key loopholes in policies that required to be addressed (i.e. production protocols). However, what appears more important to address is the poor efficiency, monitoring and enforcement of policies. Therefore, the legal framework under which the tilapia industry is regulated, can be considered as being excessive (highly regulated) in some instances, and incomplete in others (low regulation), but in both cases with poor enforcement and monitoring. In the first case, though some businesses might find it adequate, it could put off some entrepreneurs because of uncertainties and randomness of regulations, and might give an impression of compliance and reporting being too costly. In the second case, though it could seem a good opportunity for some businesses, it could also easily result in chaos, conflict, breakdowns and eventual collapse of the industry/business due to little protection and high risks involved.

All this suggest perhaps the need for governmental institutions and their regulations to be more user-friendly, understand the conditions and limitations of the people involved in this activity and focus on finding the best ways to get the message across in relation of the importance of following the policies. Therefore, the regulations and processes need to be simplified and their implementation promoted. Although some advances have been made in parallel with the requirement for aquaculture activities with agriculture and livestock, more still needs to be done, especially in its land and water tariffs and permits, and environmental issues. As legal land ownership would improve the financial risk perception of the industry, and the implementation of sustainable production systems would ensure a long term development of the industry. Additionally, tilapia farming could easily follow or adopt some of the regulations related to management protocols already created for the production of other species, i.e. shrimp.

According to the 2001–06 aquaculture and fisheries governmental development program (SAGARPA, 2001), the future trends in the short term will see more policies being developed for the increasing number of fisheries in decline, more actions to up-date the legal framework, more efficient actions for issuing permits, concessions and authorisations, and increasing enforcement and monitoring of regulations. If successfully achieved, these new measures would address two of the major issues raised by the interviewees, bureaucracy and permit costs. The various strategies defined by SAGARPA to address these issues can be found in Appendix 19. As it can be noted, most of these strategies are related to increased public sector expenditure and more efficient approaches to manage the sector, i.e. developing more efficient policies and strengthening of the monitoring and coordination of regulatory bodies.

5.6.3 Support and development programs for the tilapia industry

Amongst the main objectives defined by CONAPESCA in its fishery and aquaculture development program (SAGARPA, 2001), one program is particularly focused in the development of the industry through the promotion of the economic and social profitability of the aquaculture and fishery sectors. The strategies defined to achieve this objective are:

the promotion of the organisation and training of producers;

the development of productive chains to allow producers to keep a larger portion of the added value;

fortification of the growth and diversification of aquaculture;

up-date the methods used for capture;

promote an up-dated and competitive industry within the sector;

promote the modernisation of the fisheries and aquaculture infrastructure, and rehabilitate the natural conditions of coastal lagoons systems; and

promote business opportunities within the sector.

A further description of the set of activities defined for these strategies can be found in Appendix 16. As noted, development institutions will be concentrating their efforts not only on the producer, but in a more holistic approach to develop the industry, in what CONAPESCA defined as “value webs” or “production chains”, including this time processors, distributors and traders. The success of the program will depend therefore, on the coordination of the different institutions and the clear understanding of the requirements of each sector.

In relation to research institutions, more research will be expected in the short term, as one of the main commitments of the present administration is to increase research and development expenditure from 0.4% of the GNP in 2001 to 1% in 2006 (OECD, 2002). However, it is not yet clear how the coordination between research institutions, producers and development organisations will be improved.

Mexico has an impressive infrastructure of research institutes, centres, and universities, with many investigators already conducting research related to aquaculture. SEMARNAP has developed joint relationships with some institutions, and CONACYT encourages applied research through its grant programs. Whenever possible, these and other institutions should encourage collaboration among researchers. However, while numerous institutions are carrying out work on farm level and ecosystem monitoring, this work is less useful than it could be because of the lack of coordination among researchers (de Walt, 2002).

5.6.4 Financing of the tilapia industry

According to the objectives set in its last development plan for fishery and aquaculture (Appendix 16), SAGARPA focused on improving the coordination of the industry to allow better profits to producers as well as to promote a stronger sense of business when engaging in aquaculture projects.

Getting access to capital for the expensive process of tilapia production was one of the principal problems reported by producers (87%). Reflecting the perception of the industry as highly risky by financers, opting to gamble for more secure options (i.e. trade or non-agricultural industries) (Jorge Reyes, 2004, pers. comm.). People from the private sector complained that most of the capital was available only to the social sector, while those from the social sector made the opposite claim, as normally the land was not owned by them and they were unable to raise capital without collateral. According to FIRA (2006), loans will become more accessible and ad hoc to the requirements of the industry. However, better promotional and informational schemes would need to be established to make sure that the products (loans) are reaching their target (producers).

Because of the potential for substantial profits in the industry, it is apparent that it is far easier to get a loan for aquaculture than for most agriculture or livestock operations. There is a diversity of investment sources for both social sector and private sector producers, including loans to construct farms, hatcheries, feed plants, and other operations, as well as to provide operating capital after the facilities are in place. Borrowers would like to have more sources, more capital, and lower interest rates, of course, but these wishes would be expressed in any sector of the economy.

After having analysed and developed a clear understanding of the tilapia production (particularly through farming), its marketing and the business environment of the tilapia industry, the following chapter (Chapter 6) will discuss the main findings of the study, summarise the main conclusions, and provide key recommendations that could help in its development.

Chapter 6 Discussions, Conclusions and Recommendations

6.1 Discussions

6.1.1 The research problem

The purpose of this chapter is to assess the evidence developed in the previous chapters, describing how tilapia can be produced competitively and profitably through aquaculture in Mexico, how product quality can be promoted to meet standards of key markets, and how public/private sector partnerships can be promoted for appropriate development. It answers the original hypothesis of the study, “tilapia production in Mexico trough aquaculture has considerable scope for profitable expansion if competitive product quality is attained through active public/private sector development” and examines the extent to which these can be supported

6.1.2 Success of tilapia farming in Mexico

The study has shown that tilapia can be produced in Mexico competitively and profitably through aquaculture. However, tilapia farming in Mexico still is in its early stages of development, with the majority of the operations being small scale and with a marginal contribution to domestic supply of only 1.4% of the total national production (964 t) in 2003 (Figure 4.1). Nevertheless, the last decade showed an expansion of more commercial activities, in both social and private sectors, encouraged by the increase of governmental promotion, private investment, domestic demand for quality fresh products and the availability of new technologies. The general consensus of tilapia farmers in Mexico was of an improving financial situation, albeit compromised by several key issues i.e. competing wild and imported products, high operational costs, poor support from governmental institutions, negative perception of the business by investors and the product by consumers, and lack of product differentiation. The following sections aim to conclude evaluation of the two main components of the research hypothesis, the competitiveness and the profitability of the activity. Two main issues are the focus: the technology employed for its production and the socio-economical benefits of the activity.

Technology employed for tilapia farming in Mexico

Clearly there is scope for tilapia farming to deliver a fresh product of high quality designed for the domestic market, subject to technology and husbandry techniques, as described in chapter 3.

Production Systems

According to Watanabe *et al.* (2002), the increased production of farmed tilapia in the Americas is in large due to their adaptability to a diverse array of production systems. Tilapia farming in Mexico has been described employing a wide range of system types and technologies, ranging from extensive and ranching-like operations (reservoirs stocked with fingerlings) to intensive methods (Alvarez et al., 1999; Alvarez, 2003; Castañeda, 2003; Fitzsimmons, 2000a; Hernandez and Noriega, 1991; Hernandez et al., 2001; Morales, 1991; Pullin et al., 1997; Ramirez and Sanchez, 1997). Although culture methods have become more intensive in recent years, with improved feeds, development of cage, pond, tank and raceway culture, genetic manipulations and more skilled producers (Fitzsimmons, 2000a).

Nevertheless, according to the research findings, most tilapia farming in Mexico was carried out in small operations, 85% of the businesses covered in the study produced less than 100 t yr^{-1}. Many of these small farms belonged to the social sector, whereas the larger producers usually belonged to the private sector. This situation clearly shows the results of earlier governmental efforts towards the activity, focusing in projects with social aims (Ramirez and Sanchez, 1997), but neglecting its commercial potential.

The level of specialisation and the type of systems employed varied according the location (i.e. region or state) and the level/type of investment, i.e. private or social sectors, rather than its suitability according to local conditions. Farmers from the social sector commonly employed concrete tanks, "trinchera type" (lined tanks with walls made of sand bags), ponds and cages in a regionalised fashion; whereas private farms normally employed tanks (concrete and lined with metal frames), lined ponds and cages in RAS and open design, regardless of the region.

Although apparently the design was defined in relation to the suitability of the region (e.g. the ground in south east of the country is porous and no rivers or lakes can be found, thus only tanks were used), with tanks and ponds being used also as reservoirs to irrigate crops, and trench-type tanks and cages preferred due to their low cost. Farmers knew little about the benefits of employing other systems, and sometimes incurring in less efficient practices in relation to their particular needs.

According to the research, the types of systems more commonly employed to grow out tilapia in Mexico were tanks (56%), followed by ponds (43%) and cages (33%). The former were normally round and made of concrete or bricks. However, with recent popularity lined tanks with a metallic frame have being employed as a cheaper option, commonly preferred amongst the others because of their practicability and control for handling and maintenance. Ponds, lined in few cases, were normally used in extensive or semi-intensive cultures, and in many cases, large ponds were designed for the culture of other species like prawns. Cages were more commonly used by the social sector in places where water was abundant; cages were typically small (averaging 5 m^3) and made of cheap materials; popular amongst fishermen due to their low cost and suitability to complement their activity.

Private farms were normally the only ones fitted with complete culture cycle (typically comprised by a hatchery, sex-reversal, nursery and ongrowing area), while the social sector solely grew-up the tilapia, as fingerlings were supplied by 25 major governmental hatcheries distributed all around the country. The free distribution of fingerlings by the latter, was considering as an important factor hindering the development of private hatcheries, as businesses had to cover their production costs and the industry too small to compete against free sources.

An important issue perhaps, was the small amount (less than 25%) of farmers involved in more efficient use of resources, i.e. integration with agriculture and livestock and polycultures. Apart of the more common employment of pond/tanks as reservoirs for irrigation, there was only one case of a commercial operation integrated with agriculture and livestock.

Technology and husbandry

The research found that key technological features that improved the culture of tilapia in Mexico were: development of culture protocols, improved strains, feeds and feeding regimes, suitable infrastructure (i.e. systems, roads, storage rooms, etc.), equipment (i.e. aeration and anti-bird mesh), and water quality and reproduction management. However, these techniques were normally available only to private commercial farms due to the higher costs involved; while many farms from the social sector lacked the knowledge to produce their own fingerlings and husbandry skills for intensive cultures.

Nevertheless, perhaps one main factor that hindered the development of the tilapia aquaculture industry in Mexico was the poor involvement of the government in commercial farming; resulting in private commercial farms developing almost entirely on their own, thus becoming sometimes reluctant and wary on sharing their knowledge and experiences. This situation could explain perhaps, the development level gap between social and private sector operations. Nevertheless, this also shows that the knowledge and skills required for commercial farming were available in the country, and with proper arrangements between private and public sector, the breadth of knowledge could easily be transferred from the more skilled individuals to the less experienced.

Economical benefits of tilapia farming in Mexico

The number of species produced in aquaculture is gradually increasing (FAO, 1998), however, there is evidence of focus around certain groups, for reasons of technical capability, market attributes and consumer familiarity; where tilapia particularly is highlighted for its potential to become a major component of supply (Young et al., 2000).

Furthermore, tilapia has been proposed as a prime candidate for the "aquatic chicken" because of its desirable product attributes, i.e. simplicity of rearing, hardiness, versatility, undemanding feed requirements, with minimal dependence on fish meal and oil resources, firm flesh texture and neutral flavour (ICLARM, 1984; Maclean, 1984). Such characteristics potentially favour wide-spread acceptance in a range of different product formats in different market segments. Additionally, the scope for such growth in supply may be encouraged by the increasing potential created by technological improvement (i.e. culture systems, husbandry, genetics, feeds and equipment) and the reduced availability of other traditional species, especially from capture fisheries.

Alvarez-Torres et al. (1999) described the increased socio-economical benefits that aquaculture in general and rural aquaculture in particular, have provided to Mexico, highlighting the supply of a nutritive source of animal food protein to rural regions as well as promoting development through integration with other agricultural activities, thus improving their incomes. Nevertheless, Not too much has been said about the economic benefits of commercial tilapia farming in Mexico in the literature; most probably as a result of its small role in domestic supply, poor monitoring and its great diversity, which makes it difficult to generate an accurate picture of the activity within the country.

The research findings showed however, that tilapia farming in Mexico can be highly profitable and can promote a wide array of benefits to both, the producer and the region as a wide number of successful cases were found. Though, profitability was found to be critically dependent upon employing economies of scale and keeping production costs low, strategic targeting of niche markets and/or product differentiation from competitors. Businesses with outputs over 100 t yr^{-1} reported production costs more than half lower (median value MX$ 11.7 kg^{-1}) than smaller businesses (< 100 t yr^{-1}) (median value MX$ 24.3 kg^{-1}); with values similar to the purchasing price paid by tilapia importers in Mexico (MX$ 10.5 kg^{-1}).

Additionally, the study also found other benefits derived from tilapia farming in Mexico. These included the supply of fresh and live product at almost any given time during the year to nearby restaurants and consumers. Fiscal strategy (i.e. discounts and taxes invested in agri-businesses operations). Increase profitability in land and water usage in rural areas when integrated with other agricultural activities and polycultures with other species. Social and environmentally friendly motives to more invasive activities (i.e. quarries). Demonstrative and/or educational purposes. And as cheap source of live food for other species in zoo's and animal parks (i.e. carnivorous fishes, turtles and aquatic birds and mammals). These situations showed the versatility and the wide range of beneficial applications that tilapia farming could provide to other economical activities.

Commercial tilapia farmers reported production costs ranging between MX$ 3 to 18 kg^{-1} (median value MX$ 12 kg^{-1}) and selling prices at the farm gate between MX$ 14 to 50 kg^{-1} (median value MX$ 20 kg^{-1}), with profits ranging between 20 to 200% (median value 80%). The largest businesses registered values closer to the median, while smaller farms towards the upper and lower ends. However, the largest profits where found on farms selling value-added products (e.g. fillets and fried ready-to-eat tilapia) to end traders/users of the marketing chain (e.g. restaurants and final consumer); while the lowest profits were found on farms dealing with primary links of the chain based in highly competitive markets. In which tilapia products are not differentiated according to the source, particularly for fresh-gutted tilapia sold to major wholesale centres (i.e. Mexico City, Guadalajara and Monterrey).

Nevertheless, farmers' market target driven by the practicality of selling their entire production to only one customer (i.e. wholesalers), did very little to differentiate their product from competing sources. Thus failing to exploit the main advantages of a farmed product, i.e. fresher (recently harvested), healthier (i.e. less likely to be spoiled and/or food borne diseases-free), reliable (i.e. volume and periodicity of supply) and even customised to customers requirements (i.e. size, colour, shape, specie, etc.).

In keeping with the earlier work of Fitzsimmons (2002), the relatively high costs of production in Mexico have been shown to be problematic with the major producers (i.e. China, Philippines, Indonesia, Brazil, Ecuador, Thailand, Honduras and Costa Rica) reporting costs 45 to 25 % lower. (i.e. between US$ 0.80 to 0.90 kg^{-1}). This weakness is a key issue that Mexican producers must address, especially when considering the increasing presence of imported tilapia products in the Mexican market. Figures suggested that particular attention should be given not only to the type of feed employed and its cost, but also to its administration and performance; which require advanced management skills. As feed costs median value of farms interviewed was 54%, with less than 10% employing intensive cultures and/or large operations; whereas feed costs commonly represent up to 60% of the production costs in intensive cultures world wide (Muir et al., 2000).

Larger profits could not be linked to the employment of a single production system type, as the larger profits were found on cage, pond and tank cultures. However, the former (cage farming) has been described demanding low to moderate capital investment (McGinty et al., 2004; Muir et al., 2000); which in addition to its lower operational costs (i.e. low or non electricity consumption, no large extensions of land ownership required, and no specialised infrastructure for water supply and artificial aeration required), commonly resulted in profitable businesses.

Nevertheless, the broad perception towards tilapia farming in Mexico amongst farmers was mixed; with just over half of the farms (52%) surveyed claiming net socio-economic gain through tilapia farming whilst the balance claimed it remained the same or worse. Additionally, slightly more than half of farmers having other sources of income apart from tilapia farming, considered it as more profitable and more feasible than the other economical activities (58 and 53% respectively). Negative perceptions however, were mostly found in small businesses and/or new entrants to the industry with limited experience in the sector (where almost 80% had been in business less than 5 years). Commonly as a result of their high production costs and low outputs, especially within small producers belonging to the social sector. Who very often invested more efforts in getting subsidies than being productive and economically viable. This shows the important role that experience, support and economies of scale can play in the viability of the industry. Whereas it also suggests that compared to other agricultural activities, tilapia farming is represents a more viable solution of rural development.

6.1.3 Potential of farmed tilapia products in the Mexican market

Mexico is a predominantly meat consuming country. As it can be appreciated in Table 6.1, chicken, beef and pork represent the most consumed sources of animal protein, with per capita consumptions of 22.1, 16.9 and 14.1 kg respectively; significantly higher than seafood in general (8.3 kg) and tilapia in particular (0.6 kg). Nevertheless, tilapia has become an important fish commodity in Mexico, representing in 2002 not only the fifth seafood commodity most consumed in the country, but also the fish commodity in the fresh presentation as well as the freshwater species most consumed in the country (CONAPESCA, 2003).

Table 6.1 Consumption (apparent and per capita) of meat and seafood commodities in Mexico in 2002 (CONAPESCA, 2002).

	Commodity (Generic Specie)	Consumption Apparent (t)	Consumption Per Capita (Kg)
Meat Commodities	Chicken	2,301,071	22.10
	Beef	1,757,637	16.90
	Pork	1,473,605	14.10
	Turckey	123,960	1.20
	Lamb	96,454	0.90
	Goat	42,852	0.40
Seafood commodities	Seafood (All)	874,549	8.30
	Tunids	149,288	1.42
	Sardin/Mackerel	112,968	1.07
	Squid	73,726	0.70
	Shrimp	69,078	0.66
	Tilapia	63,248	0.60
	Oyster	51,325	0.49
	Shark	28,418	0.27

Since it was first introduced to the Mexican market (1967), tilapia has been mostly supplied by the catching sector; representing 91% (67,179 t) of the national supply in 2003; while imports and aquaculture represented only 7.3% and 1.3% respectively (CONAPESCA, 2003). Nevertheless, domestic supply has seen a downfall within the past decade, falling 23% from its highest peak (nearly 100,000 t) in 1996 (Figure 6.1); mainly as a result of reduced outputs from the catching sector due to overfishing. The value of the production on the other hand, remained relatively stable as a result of increasing or stable prices. Contrasting with increasing import of tilapia products since 1995, and stagnant outputs from aquaculture (Figure 4.1). This situation has had a major impact on the domestic market within the past decade, resulting in major changes in product availability, types of products traded, prices, distribution channels employed and perception of the product.

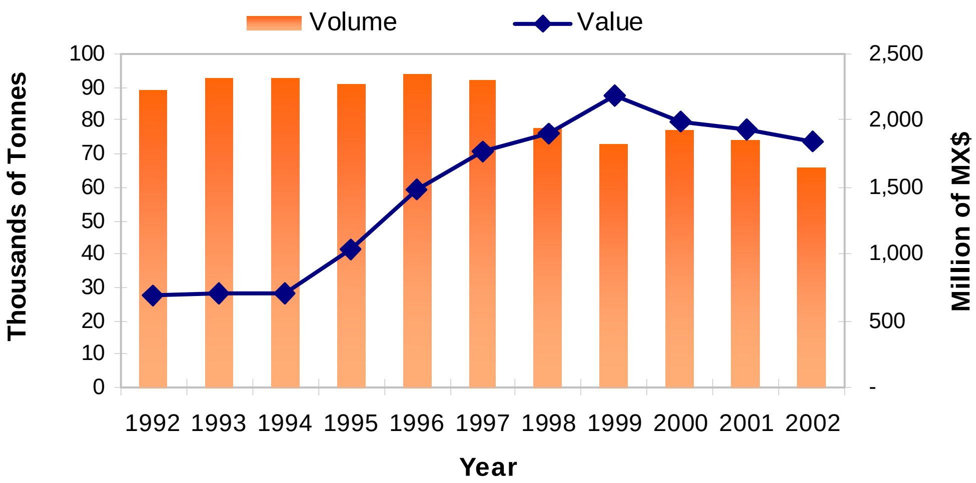

Figure 6.1 Volume (thousands of Tonnes) and value (millions of MX$) of domestically produced tilapia (including fisheries and aquaculture) supplied to the Mexican market (CONAPESCA, 2002).

Sources of tilapia to the Mexican market

Tilapia from the catching sector

To simplify the analysis for the study, these figures were considered within the catching sector. The decline in production occurred in most fisheries, while only a few reservoirs registered stable or increased outputs, i.e. Aguamilpa, and El Salto. Not surprisingly though, these were the only fisheries, properly managed and regulated. Overfishing was found to be the result of various malpractices, the most important are summarised in Table 6.2. As elsewhere this situation was worsened through poor monitoring and support from governmental bodies; of the nearly 100 water bodies (including reservoirs, lakes and rivers) with tilapia fisheries, only 12 had some sort of established regulation.

Moreover, this sector seemed to be further aggravated by other factors like: the complexity of the industry (involving a series of activities, players and policies for its operation); the traditional culture in the country for un-sustainable exploitation of the natural resources; and the fertility and productivity wane of the reservoirs, as the majority of the main reservoirs were built within recent time (less than 40 yr) (CNA, 2005), which allowed the first generations to use the rich organic matter , and the high natural productivity (Perez-Velazquez, 2002). This suggests that it will require serious efforts and time until real changes start to show up within the sector.

Table 6.2 Main causes of overfishing in tilapia fisheries (Perez-Velazquez, 2002).

Factor	***Effect***
Exceeded number of fishermen	*Increase fishing pressure*
Exceeded number of gill nets used per fishermen	*Increase fishing pressure with up to 80 nets per fishermen, while the allowance is normally 5*
Clandestine fishing	*Increase fishing pressure and disruption of protected areas*
Employment of smaller mesh sizes	*Reducing breeding life of the fish and stunting of populations, sometimes using up to 2.25", while the permitted is 3.5".*
Exceeding fishing quotas	*Increasing fishing pressure*
Infringement of close seasons and periods	*Disrupting breeding season, resulting in reduce recruitment.*
Employment of techniques and equipment not allowed for fishing	*Damaging the environment and the sustainability of the fishery.*
Fishing in protected breeding areas	*Disrupting breeding and recruitment of the water body.*

Imported tilapia

Around 90% of the imported tilapia consumed in Mexico is produced in China (including Taiwan). However, these products enter the country mainly through the USA and to a lesser extent, Canada so as to avoid taxes through NAFTA. Imports from the USA started only a decade ago (1995), and have been constantly increasing since then. Most of these imported products enter the country through two major bordering cities, Tijuana (Baja California State), and Nuevo Laredo (Tamaulipas State); with the former as the major entrance to the country, as is the closest point to the major importing cities in the US, Los Angeles and San Diego in California. The latter (Nuevo Laredo) was supplied from Houston, Texas. Other countries exporting to Mexico include Ecuador, Honduras, Cuba and Costa Rica, although their exports have been sporadic due to cheaper Chinese products.

The growth in imported supplies is important since it clearly reflects the willingness and ability of consumers within the Mexican market to buy tilapia. But at a price level which is often below that which can be offered profitably by Mexican farmers. Thus to compete on the market for tilapia Mexican producers would seem to have to devise a strategy which will combine cost reductions and/or enable price premiums to be charged through (superior) product differentiation. In section 6.1.2 it was shown that scope for cost reductions was greatest in feeds, electricity and technology; whilst product differentiation was highlighted in section 6.1.3 through the marketing of higher quality fresh products. The implications of these potential strategies are returned to later in section 6.2.

Domestic farmed tilapia

The supply of tilapia to the domestic market from this sector saw a strong decline in the past few years (around 50%), primarily because of the reduced output from Pisimex, then leading producer. Despite their strong position within key profitable markets (i.e. supermarkets) their demise highlights the underlying challenges for the relatively small scale producer against international competitors who will be eager to maintain a share of an increasingly profitable domestic market. Nevertheless, supplies from this sector are expected to grow, as in some regions of the country, there have been increasing efforts from developmental institutions to promote the activity within the social sector, with a more commercial approach. Also, as more profitable businesses emerge, there is a greater awareness of the investment potential thus attracting more entrepreneurs, and greater competition. Scope exists for co-operation between producers and suppliers, with better technology transfer and reduced inputs prices (Martinez et al., 2004). Additionally, the strong supplies from the catching sector and imports have created an increasing domestic demand for high quality fresh products.

Assessing actual performance of the sector is problematic because of the poor quality of the data throughout the supply chain, as discussed in chapter 4. This fundamental deficiency in the marketing information system makes it far more difficult for actors to assess their own relative performance and is particularly problematic for smaller producers with accordingly diminished market shares. Institutional infrastructure support in improving marketing information could be a significant determinant of the future ability of the indigenous sector to compete and will be discussed in more detail at section 6.1.4.

Type of products supplied by major sources

According to the research, the type of product supplied to the Mexican market was source related. As it can be appreciated in Table 6.3, gutted and fillets were the most common processes applied to tilapia, though the latter (fillets) were mostly supplied by the import and catching sectors. Furthermore, product size of wild products tended to be smaller (probably as a result of overfishing), whereas aquaculture products were of a medium size (~500g), and imported products were the only source able to supply all sizes (including large, i.e. > 750 g) constantly. All imported products were traded frozen at the wholesale level; while all tilapia produced domestically (i.e. fisheries and aquaculture) were traded fresh. This represents a potential comparative advantage for farmed products, as the general believe within the Mexican consumer that frozen products are not fresh and therefore of less quality (Telles-Castaneda, 2003). Reason why tilapia is commonly preferred fresh within the trade of the retail sector.

Moreover, handling and quality of the process varied greatly between the products in relation to their source. “Wild product” normally showed the poorest conditions, whereas farmed and imported products the best presentations, i.e. gutted fresh for the former and fillets for the latter. Farmed products were rarely filleted as typical harvest size would yield a product (1-3 oz) that competes directly with much cheaper options (i.e. fisheries). Therefore, harvest of larger sizes might represent a potential opportunity for farmed products to access more profitable and less competing markets.

Table 6.3 Main type of products supplied to the Mexican market by the various sources.

Source	Process	Size	Presentation
Fisheries	Gutted, Fillet	G: 150-750 g (0.3-1.5 lb); F: 25-50 g (1-2 oz)	Fresh
Aquaculture	Live, Round and Gutted	250-750 g (0.5-1.5 lb)	Fresh
Imports	Gutted, Fillet	G: 250-1000 g (0.5-2 lb); F: 25-200 g (1-7 oz)	Frozen

Value added products had also different presentations according to the source: farmers sometimes sold fresh fillet and ready-to-eat products (deep-fried tilapia). Processors of wild tilapia (i.e. middlemen and industrial processors), produced fresh fillets in bulk; the former typically employed low-cost technology and infrastructure, while the latter produced a wider range of products, i.e. skinned-deboned frozen tilapia fillets packed in 1 Kg trays, breaded fillets, fish fingers and fish figures/shapes in 500 g packs, and ceviche in cups, employing more advance technological processes and infrastructure. Imported products were traded in a wide variety of filleted and gutted presentations, i.e. various sizes, skinned, deep-skinned, deboned and individually vacuum-packed for fillets, gutted, scaled and individually bagged whole products, both packed in 18 kg (40 lb) boxes. Which shows first of all, the versatility and suitability of tilapia to be traded in a wide variety of presentations, but also the contrasting development level of the market for wild and imported products compared to farmed products.

The largest processing plant of tilapia products in Mexico, "Pisimex", who used to produce its own product through farming, imported tilapia to process, and produced skinned and deep-skinned, deboned, fresh and frozen fillets in 1 Kg packs and branded their product with a new name, "Blanco del Nilo" (White of the Nile); a strategy that has been employed by other traders (including farmers) with names like "Blanco de Orinete" (White from the East) (light skinned fillet), "Blanco Real" (Royal White) (deep-skinned fillet), "Perca del Nilo" (Nile Perch), "Pargo Cerezo" (Cherry Snapper), etc.; but also becoming a nomenclature issue along the industry. However, this situation has been found controversial by some traders, claiming it is unlawful and deceiving to the consumers, attempting to sell tilapia as something else. Nevertheless, the trade of added-value tilapia products have helped to improve the perception of tilapia within the domestic market, as now is considered as an affordable and good quality seafood product, attracting other sectors of the population like higher income consumers, willing to pay for better presentations. Additionally, by adding value to the product, also provides the opportunity to incorporate non-fish components (i.e. dressings, packing) and additional attributes (service) to the business. All of which also add to the value perceived by the market.

The study found medium and large fresh fillets (> 90 g or 3 oz) to be in greatest demand and increasing within the domestic market, as preferred by the majority of supermarkets and restaurants. Basically all fillets traded from these sizes were imported, though its relative market share growth was difficult to assess due to due to the lack of official figures. This is apparent emergence of a preference for fresh product is significant because imports tend to be in frozen format and would incur additional costs and logistical barriers if they were to arrive in a fresh format.

Marketing channels of tilapia products in Mexico

The marketing process for tilapia products in Mexico was discussed in chapter 4 which noted that marketing channels for seafood in Mexico in general and for tilapia in particular, were complicated, since some market operators may perform more than one marketing function and among each type of market operator there may be an internal flow of fish products, especially in the case of wholesalers and retailers.

The marketing channels followed by farmed products proved to be the most simple and straight forward to reach the final consumer, mainly as a result of the large proportion of producers with small outputs, only capable to retail their produce at the farm gate. Larger producers (>100 t yr^{-1}) on the other hand, typically traded with wholesalers, as resulted more convenient due to the lack of infrastructure for processing and distribution, as well as the need to sell the whole harvest quickly. This strategy however, resulted in fewer profits. This suggests the opportunity for expansion of the tilapia farming industry into more profitable markets, i.e. supermarkets, fishmongers and restaurants; which might require greater efforts and investment for product differentiation, and a more holistic service (e.g. quality reassurance, wider range of products and delivery). Nevertheless, the direct trade to consumers and retailing businesses has benefited the perception of farmed tilapia products, considered in many occasions, as a fresher, healthier, more secure and cleaner product; especially when compared to wild tilapia.

In contrast, the channels followed by wild and imported products involved grater number players, as described in Chapter 4; with up to two different types of middlemen involved in the trade of tilapia from fisheries, and a series of brokers (exporters/importer) in the trade of imported tilapia products. Although both sectors were essential in the trade of these products, most of the trade was done through major wholesalers; who typically focused their efforts to trade these products as a more generic product (mojarra-tilapia or tilapia), placing less importance into the origin of the product. Condition that was also reflected up-stream the marketing chain, were imported products were commonly defrosted to be sold as fresh.

This shows how wholesalers played a key role as market stabilisers, balancing the demand and supply of tilapia products among different regions, by storing large volumes of tilapia products away and selling them when domestic supplies were low at higher prices. Trade of tilapia has become so important in Mexico that 17% of the wholesalers covered by the study were specialised in only trading tilapia; while for many others, tilapia trade represented an important share of their income, sometimes up to 80%.

An important factor that has promoted the trade of imported products in Mexico, is the strong competition between producing countries to enter the lucrative US market, resulting in cheaper products with excellent and wide variety of presentations, and available in large volumes all year around. Additionally to this, as imported products were traded frozen and well packed, according to many traders the products were a lot more easy to handle and store, making its trade a lot more practical. These perhaps, are the main reasons of why imported products have positioned themselves so well and so fast within the Mexican market, and why the supermarkets and fishmongers have become their main retail outlets.

One of the important factors that showed the level of development of the industry for fishery and imported products was the close relationship as well as financial and legal bonds between traders. With strong agreements between fishermen-middlemen-wholesaler and between broker-wholesaler; commonly in the form of supply agreements, advanced payments and loans for the former, and legally-binding contracts for the later as large volumes were traded and administrative and legal paper work was more complicated. Suggesting the importance of developing long term relationships in a win-win situation, were legal and financial ties helped to improve the trust between businesses.

Supermarket chains and processors were the only market operator to follow a quality certification scheme, i.e. ISO (9000 and 14000) or HACCP. A situation that drove supermarkets to have preference for suppliers that could deliver that level of standards; in the case of tilapia, only imported products were certified as is a requisite to enter the US. This suggests that if these certification schemes where adopted, farmed products could access competitively to the increasingly lucrative supermarket market niches, especially if differentiated from the rest by highlighting the strengths of farmed tilapia products, i.e. its freshness, locally farmed produced, and produced employing the highest standards.

Nevertheless, the increased trade of tilapia through supermarkets (mostly thawed) has resulted in an expansion of sectors within the Mexican population demanding these products, with recent increasing demand of higher income sectors. This can be explained due to the key advantage of supermarkets, which lies in their practicality for shopping, allowing consumers to purchase all their goods in only one place. This situation is particularly appealing to medium and high income consumers, who would normally have more disposable income and be willing to pay premium prices for well presented and appealing products (Seafood Today, 2004). At the time of the study, most of the tilapia traded by supermarkets was imported, as was the only source able to reassure supply and quality. When sold to consumers, tilapia was commonly defrosted.

Fishmongers still represent the main outlet of tilapia products to the final consumer, not only because their market coverage is still greater than supermarkets, with nearly three times more outlets, and could be found from remote villages to low income neighbourhoods in major cities, a situation that benefits particularly the trade of cheap products like tilapia; but also because of the general perception of Mexican consumers towards the fishmonger, as a more reliable source of fresh seafood.

Seafood restaurants were the main outlet to final consumers of tilapia products within the food service sector. Fast-food and self-service restaurants and caterers rarely used tilapia products, as the former (fast-food and self-service restaurants) are normally represented by small restaurants that sell traditional or foreign dishes (i.e. tacos, empanadas, tamales, grilled or roast chicken, hamburgers and hot dogs); seafood cocktail restaurants were an important sector, but normally employed only shellfish. Caterers on the other hand, were keen on well known marine species, which were also reliable in relation to quality and consistent availability. Supplies of tilapia products to restaurants were mainly from wholesalers and retailers, only 6% of the businesses covered by the study were supplied by producers (fisheries and farmers). As discussed in chapter 4, food services are perhaps the most lucrative businesses within the marketing chain, where the profits reach the highest percentage per unit volume traded; therefore is the sector where freshness and quality are of prime importance to businesses, a situation that represents a huge potential for the expansion of farmed tilapia products.

Restaurants were a major outlet of tilapia products in some regions of the country, particularly within the south. Similar to fishmongers, restaurants could also be found in remote villages and low income neighbourhoods, but in contrast with the rest of the country, there were well established popular dishes in which tilapia was consumed creating a high demand. Though products were more likely to come from local fisheries, targeting this sector and region clearly represent a business opportunity for tilapia farmers, as the location is suitable for production and attractive profits can be achieved. Especially when considering demand for fresh products of good quality (freshness and size) by restaurants and the decline of outputs in local fisheries.

Market behaviour

As suggested previously, the price of tilapia varied according to the source. In the Mexican market, wild tilapia products resulted cheaper compared to other sources, averaging MX$ 6.00 kg^{-1} for gutted and MX$ 18.00 kg^{-1} for filleted products at the bottom of the supply chain (fishermen and middlemen respectively). Whereas imported products were 2.5 and 3 times more expensive than wild products, and farmed products 4.5 and 4 times more expensive (Figures 4.12 & 4.13). However, due to the large proportion of small scale farmers within the industry with high production costs, the average price of farmed tilapia (gutted) offered at the farm gate was higher than the average purchasing price on most marketing operators for the same product, except for restaurants. Thus the cheapest option for consumers to purchase tilapia was the fishmongers, as farmed products prices for gutted and filleted products resulted 1.2 and 1.8 times more expensive than the former. Nevertheless, production cost of the larger farms (i.e. > 100 t yr-1) was similar to the price paid by importers (i.e. around MX$10 kg^{-1} for gutted tilapia). This clearly shows the great price disadvantage of the smaller farms in relation to wild and imported products, and highlights perhaps, one of the strongest weaknesses for the tilapia farming industry; which need to be addressed, if it is to expand and compete in the domestic market. On the other hand however, it also shows that tilapia farming can be competitive and profitable in Mexico if economies of scales are employed.

Having said that, the study also showed that the trade of domestic tilapia products (i.e. gutted and filleted), especially wild tilapia, yielded better profits in most market operators, with the exception of imported gutted tilapia products traded by wholesalers and restaurants. The higher profit of wild products could be explained by the low production cost of the product, allowing a greater distribution of profits along the marketing chain. Additionally, the preference for fresh products compared to frozen products sometimes helped to achieve better prices, as in many occasions, the general perception of fresh product, is of good quality. However, wholesalers and restaurants achieved high profits with imported products most probably due to the larger sizes available (> 750 g), which normally fetched higher profits, especially in the case of restaurants. Additionally the much better packing of the imported products usually appealed more to retailing businesses due to their easy handling and storing capabilities, especially when purchasing large volumes.

However, retailers normally had to defrost all imported products so they could be sold as fresh, thus having to absorb the 10% weight loss through thawing (due to the glazing layer); a situation that wholesalers were exempted from. Although, according to fishmongers the appearance of a defrosted product, especially gutted, never matched the appearance of fresh product. These three situations show however, the controversies that could exist for a particular product along the marketing chain, where down the line tilapia products are preferred frozen and properly packed, while at the top end, the Mexican consumer has a strong preference for fresh tilapia products at the fishmongers and large sizes at the restaurants. This suggest some clear opportunities for small/medium and large tilapia farms; where the former with smaller outputs should aim at retailing businesses (i.e. individual supermarket stores, fishmongers and restaurants), with large fresh products; whereas the latter with larger outputs, should aim at businesses down the marketing chain line (e.g. wholesalers and supermarkets), with products frozen and well packed.

Nevertheless, although gutted products yielded a higher profit for domestic producers (i.e. fishermen and farmers), larger volumes of product (prior process) could be easier to trade in the fillet form. This raises questions of the equal importance of developing a capable processing sector able to deliver high quality products.

After analysing the market share of the tilapia industry in Mexico, the study found that the tilapia industry as a whole seemed to have a low level of concentration and very competitive, although the supply of some of the sectors resulted were dominated by a few businesses, i.e. farming and imports with CR's$_{10}$ of 148 and 80%, and HHI of 3,362 and 1,268 respectively (Table 4.2). Additionally, the study also confirmed the important role of the major seafood wholesaling centres ("La Nueva Viga", Mexico City and "Mercado del Mar", Guadalajara) in the supply of tilapia within the wholesale sector with CR_{10} 34.7% and HHI of 197. Having said that, these results also proved that the supply of the aquaculture and import sectors might be a lot higher than the official figures, as the study only covered a portion of the sector and it would have been almost impossible to cover all the businesses within the sectors, therefore the real volume of tilapia products traded might also be well above the official figures suggest. This is probably as a result of the large amount of products from the catching, farming and importing sectors traded unreported and/or illegally.

Competition was found not only between sources and businesses, but also between meat food commodities, i.e. other aquatic species and meat products. Apart of the traditional species (marine and fresh water) that competed with tilapia. However, some traders claimed that competition with other aquatic species was found only in the filleted form, as the gutted product was easier to recognise by its consumers. This is probably explained by the fact that many marine species are traded mainly in the fillet form, making it more difficult for consumers to differentiate between products of a different nature; as a result, filleted products ended up competing or substituting each other. This shows that consumers main driving forces on purchasing filleted products are more likely to be price and/or presentation related, rather than the specie. This clearly suggests that after nearly 40 yr of been marketed in Mexico, consumers have developed strong recognition and loyalty to tilapia, especially in the gutted form as it was the only presentation available before. However, this also could mean that filleted products might be more versatile than gutted products to enter and compete in more lucrative market niches, as consumers are used to purchase these types of products at low prices.

Trade of tilapia products in Mexico showed a seasonal behaviour in relation to supply and demand. The key implications of this seasonality are:

Disruption in supplies from the catching sector.

Definition of periods of greater demand and decreased supply from competing sources, in which profits could be maximised by harvesting a large proportion if not all of the production during these periods.

Allow the designation of strategies to compete in larger markets, by switching sizes of product harvested, regions and sectors targeted.

6.1.4 The current tilapia industry business environment in Mexico

The competition among strong tilapia producing countries, the rapid advances in technology and the increase in market demand suggest that the tilapia industry in general, needs to take appropriate measures to maintain its viability and competitiveness. This can be attained through active public/private sector development. Solleiro et al. (2005) agreed that in an increasingly globalised market, the new approach of competitive advantages requires a process of relations between entrepreneurial organisations and markets in which a decisive role is played by the different expressions of the power structures, both governments and interest groups, which determine the context in which firms compete. Resulting in the dynamic interaction of businesses and governments through a set of business strategies and actions, public policies and interinstitutional relations that seek to optimise value added. The study focused on assessing four main factors involved in the development of the tilapia industry in Mexico: i.e. regulations, support, financing and partnerships.

Regulations

The NOMs involved in the regulation of tilapia production focused only on few specific fisheries, typically in decline, and few activities involved in aquaculture. Out of the 26 most important tilapia fisheries in Mexico (five in rivers, four in lakes and seventeen in reservoirs), only six fisheries have been regulated and a further five are in project. Tilapia farming on the other hand, has developed in most of Mexico without adequate regulation by governments, without effective NGOs to serve as a counterbalance to the industry, and without ways for communities to monitor and evaluate resource use and over-use. The legislation of aquaculture in Mexico has become complex, voluminous and fragmented among numerous enactments, and sometimes governed by a number of overlapping laws and regulations that fall under the jurisdiction of several different agencies (Spreij, 2005).

There are only three NOMs (including one in project) that specifically regulate aquaculture, focused mainly on issues regarding the importation of live aquatic organisms and the implementation of HACCP in aquacultural businesses (in project). The government have developed regulations for species economically important for the country, i.e. shrimp (i.e. diseases and feed control) and tuna (i.e. labelling), but no regulations are available for tilapia; even though its domestic consumption is as high or even more than the former two, and its social impact could be even grater, especially when considering that the other two product are produced for the export market.

Industrial processing plants normally operated within the law, as they often targeted businesses requiring high standards on the products purchased to trade, i.e. supermarket chains. Informal processors (e.g. middlemen) on the other hand, were less likely to follow HACCP standards or any other regulations due to the employment of basic and rustic infrastructure and techniques, which would allow them to keep costs low; a situation that could easily compromising the quality of the product, and thus, the industry itself.

The regulation of the seafood trade focused only on three main issues; hygienic and health practices on fixed establishments (including methods and specifications for the monitoring of pathogens and substances in food products), labelling and the information provided (i.e.

values and contents, nutritional specifications, origin of the product, sell-by and best-consumed-before dates). As most of the tilapia sold in the retail market was fresh (including the imported product), none of this information was available. The only tilapia products with some sort of information available were the processed on industrial domestic plants and the imported, especially in the fillet form; although the latter normally did not specify the origin.

According to the study, more than half of the farms interviewed (57%), claimed finding some issues in the regulation of the activity hindering the development of their business; highlighting: the complexity of the legal system (bureaucracy), land and water ownership for aquaculture purposes as complicated and expensive, excessive tariffs and permits (especially electricity), enforcement of complicated and expensive environmental impact assessment (EIA), the lack of protocols for fish farming management, and the poor enforcement of the origin certificate for imported products. The lack of awareness and understanding of regulatory procedures, together with the poor perception of governmental institutions, have resulted in many businesses to operate informally throughout the marketing chain, especially in the case of small and micro businesses. This clearly shows the lack of understanding and affinity from both sides, thus there is a clear need to promote a closer relationship between government and producers by creating more user-friendly schemes, simplifying some of the processes and promoting the implementation of policies.

Efficient regulatory environment provides certainty to industry, government and communities to plan for the future growth of the industry, as whether and where it can grow, how it will grow, and maximising the benefits to rural and regional areas. Nevertheless, entrepreneurs complain of unpredictability as governmental institutions and their programs and regulations have varied greatly from one presidential period to another. Yet reforms in Mexico are rare, a common situation in developing countries, as the country has had the same laws and regulations for decades. The difficulties businesses face come from a lack of information and from discretion in enforcement. Thus only a few businesses comply with the regulations, since it is so prohibitively costly and complicated, so many entrepreneurs choose to operate in the informal economy. A large informal sector is bad for the economy: it creates distortions, reduces tax revenues and excludes many people from basic protections. If regulation were simplified and constantly up-dated to tackle rising problems, businesses would find benefits in moving to the formal sector, such as greater access to credit and to courts.

Promotion and support

Until recently, aquaculture development programs in Mexico concentrated on promoting only activities related to production, neglecting other sectors of the industry chain, i.e. processing and trade. SAGARPA's aquaculture development programs (2001) were defined for three main production categories; rural (i.e. social sector), restocking (i.e. fisheries) and industrial (i.e. commercial farming) aquaculture. However, most of the efforts had been directed to the former two categories, and normally neglecting commercial farming. Support schemes to the aquaculture sector in Mexico are normally provided in three main forms: financial (i.e. money), technical (i.e. research, consultancy or courses) and/or in kind (i.e. materials, equipment or consumables).

In spite of the greater number of support and development institutions available in the country, the results and the impact of these programs have not been as expected, at most these programs have been hampered by common problems related to governmental institutions like the lack of coordination between the different institutions, excessive bureaucracy, different legal framework imposed on every new government elected, high concentration of support in just a few producers, insufficient and delayed funding schemes, lack of experience of extension staff, information difficult to reach, use of the resources for political purposes, and others (Gómez et al., 1999; León, 1999; Reyes, 2003).

At the time of the study, the subjects targeted by research institutions in support of the industry, focused mostly on issues related to production. The only research carried out on marketing related issues for tilapia were on value-added products (e.g. surimis, fish fingers and packing), but sponsored by a private company and targeting particularly wild tilapia, done by CIAD. Nevertheless, a major issue was perhaps, the apparent isolation of research institutions from the industry, where in very few cases their research findings were employed by producing, processing and trading businesses. These situations show first, the lack of understanding of the major research institutions on one of the most sensible issues of tilapia farming in Mexico, the marketing of the product, which is perhaps a key factor to promote a profitable business. Secondly, it shows the poor performance of development institutions to link the wealth of knowledge from research institutions to the industry, and conversely allow the research institutions to clearly understand the requirements of the production sector.

Nevertheless, CONAPESCA seemed to address many of the issues previously discussed within their last fishery and aquaculture development program (SAGARPA, 2001); which amongst many other objectives, aimed at the development of the industry through the promotion of the economical and social profitability of the aquaculture and fishery sectors. To achieve this, the government planned to promote the organisation and training of producers, develop "productive chains" to allow producers to keep a larger portion of the added value of their production, fortify the growth and diversification of aquaculture; promote an up-dated and competitive industry within the sector; promote the modernisation of the fisheries and aquaculture infrastructure, and promote business opportunities within the sector. Efforts were focused towards the development of a more inclusive and competitive industry, including other sectors of the marketing chain through the so called "value webs" for producers, which suggest a more commercial and inclusive approach to develop the tilapia aquaculture industry.

Additionally, the creation of institutions in charge of promoting the trade of seafood product, which also includes tilapia (i.e. FIRA, BANCOMEXT, ASERCA and more recently COMEPESCA), has further promoted a more commercial-like mentality among producers; now not only worried about how to produce, but rather on how to sell it. Although perhaps too soon to assess their results, it was the general believe of various producers that this help could make the difference for their success. Especially when considering the amount of efforts required to promote the consumption and differentiation of farmed tilapia products.

Financing

Major financing institutions involved in the development of the industry were described in chapter 4. In which was highlighted the almost inexistent involvement of private institutions in financing tilapia farming projects (only 3% of the farms), contrasting with the greater role of governmental institutions (40%). However, the majority of the farmers financed their own projects (57%).

Nevertheless, the major beneficiaries from governmental financing between 1994 and 2003 have been shellfish aquaculture (ranging from 24%-54% of the budget), seafood processing (17%-52%), and lately, coastal and inland fisheries (6%-23%). Whereas financing to fish farming and marketing activities has represented only a small proportion of their budget, ranging from 0.1-1.7% for the former and 3%-9% for the latter (CONAPESCA, 2003). This clearly explains the comparable greater development of the shrimp industry in the country, while others have remained stagnant. Although it also questions the performance of these institutions towards the development of an agri-industry with great potential in Mexico, especially when considering the large number of development institutions and programs available, and the incipient growth of the industry. The main factors that have contributed to this poor performance were excessive bureaucracy, constant changing of the legal and organisational framework of the institutions, lack of interest from the social sector to become economically viable due to a comfortable dependence of governmental subsidies, and poor availability of information and promotion of support and development programs (Reyes, 2003b). In the case of private banks however, prohibitive interest rates charging annual rates of interest at about 45%, also contributed to the poor performance (de Walt, 2002; Alvarez-Torres, 2003).

Getting access to capital for the expensive process of tilapia production is one of the principal problems reported by producers. People from the private sector complained that most of the capital is available only to the social sector, while those from the social make the opposite claim as normally the land is not owned by them. According to FIRA, loans will become more accessible and ad hoc to the requirements of the industry. However, better promotional and informational schemes should be in place to make sure that the products (loans) are reaching their target (producers).

Business organisation

As previously discussed, there are two main aquaculture stakeholders in Mexico; the private sector composed of wealthier investors, and the social sector, a term that is generally used to refer to agrarian reform communities, communal organisations or production cooperatives which are mainly comprised of resource-poor individuals. The main component of the social sector is the "ejido" and it is an organisation established by the Mexican state, most aquaculture farms are held by the social sector (de Walt et al, 2002).

Nevertheless, globally, a large part of the national fishery/aquaculture sector cooperatives have failed often as a result of a combination of over-emphasis on production, bad management and the individualistic behaviour of members (Lem et al, 2004). Until recently, the lack of regularly profitable markets has force many producers in Mexico to abandon tilapia culture, even after they invested in the construction of fishponds and harvested several fish crops. For that reason, the number of abandoned and partially utilised farms in Mexico leads some researchers and investors to question the prospects for tilapia culture in the country.

Additionally, the percentage of businesses with successful development was minimal, especially when considering the 850 production units (including tilapia, catfish, trout, carp, frog, prawn and marine species) financed by SAGARPA (2006) in 2003 through its Rural Aquaculture Development Program. According to various producers (Arturo Leal, Rene Celis, Mariano Carrillo, 2003, pers. comm.) from this sector, success was difficult to reach as there were inconsistent support from governmental institutions and lack of an integral development, i.e. covering also the marketing of the product.

Martinez et al. (2004) asserts that the performance of individual firms often is enhanced by membership in a group cluster of other firms engaged in similar activities. Relationships among coexisting firms provide a source of competitive advantage for the adoption and development of an aquaculture enterprise. The business environment within a cluster is a combination of competition and cooperation that has proved to be very important in economic success. Schmitz (1997) maintains that cooperation results in collective efficiency that generates benefits in the form of local external economies and joint actions. Joint activities include formal and informal agreements for co-marketing, co-production, sharing of resources, or joint development of new products. Joint activities benefit small businesses by allowing small farms to focus their scarce resources on a particular stage of production in order to meet the demands of more complex markets.

Additionally, vertical integration is commonly suggested as a solution to reduce market imperfections and failures (Lem et al., 1994). The main advantages of businesses integrating vertically include: the reduction of transaction costs, opportunities for innovations and product differentiation, economics of information, risk reduction and improvement of market power (Williamson, 1989; de Mello Brandao-Vinholis, 2000; Perry, 1989; Porter, 1980; Zuurbier et al., 2000). However, vertical integration can also lead to disadvantages, e.g. high capital investment requirements, unbalanced throughput, reduced flexibility and increased bureaucratic distortions (Buzzell, 1983; Den Ouden et al., 1996). This implies that the benefits of vertical integration might come at significant risks and costs. Moreover, Pillay (1994) argued that vertical integration used to be considered an efficient organisational structure for aquaculture in many respects, especially in early stages of development, when input, production and distribution were poorly organised in many countries. While it continues to be so in some cases, the general tendency in organised farming appears to be towards decentralisation or a horizontal integration of activities. This is in line with many manufacturing industries and has proved to be cost-effective. Though large-scale intensive aquaculture may appear at first to be more suited for vertical integration, it is often less efficient and uneconomical because of the nature and scale of the various operations involved. Therefore, when entrepreneurs or corporate bodies decide to undertake the major activities like seed stock production, feed manufacture and marketing, they usually opt to establish separate companies for the purpose, with suitable linkages for horizontal integration.

The goal of many companies is to get access to the benefits of vertical integration while minimising the costs and its other disadvantages. In such cases vertical cooperation, which can be defined as incomplete vertical integration, may be an option. “Vertical cooperation is the alignment of direction and control across segments of a marketing system” (King, 1992) but, in contrast to vertical integration, it does not transfer full ownership and control to other segments in the chain. While under conditions of pure market exchange, control is based at each separate level it is coordinated under vertical cooperation. Under vertical integration control is centrally arranged for all participating stages in the chain. Cooperation generally takes place through better planning, information exchange, quality control, and channel leadership. However, vertical cooperation can have many forms, ranging from cooperation in only one subject to cooperation in almost all activities; which places vertical cooperation somewhere on the continuum between a situation of pure market exchange and vertical integration (Lem et al., 1994).

The study findings showed that until now, the benefits of business integration or partnerships were poorly understood and promoted in Mexico, as only a few successful cases were found within the tilapia aquaculture industry in the country. The best examples perhaps were businesses with vertical and horizontal-vertical integration. The former, best represented by what used to be the largest farm developed in the country (Pisimex), which covered the whole production and most of the marketing chain; producing their own fingerlings, ongrowing and processing the product (including packing), and selling to supermarkets. However, although the company was highly successful, it required a huge capital investment. The latter on the other hand, with two successful examples in the country (one producing catfish and another producing tilapia), conformed by partnership of a group of farmers and businesses related to the activity; in the former (catfish company) a member was in charge of the fingerling production, a group of farmers grew-up the product, and another processed (filleted, packed and frozen) and marketed (some exported) the product. The latter, (tilapia company) a member owned a feed plant, another produced the fingerlings, other processed (only gutted) and marketed the products, and a group of mixed members belonging to private and social sectors grew-up the product. Additionally, there were some cases were fishermen were expanding their activities through adopting aquaculture production (cage farming mainly), inputs supply and marketing of the product. This situation although shows the poor understanding and little promotion of advantages and potential of these sort of businesses, these examples clearly demonstrate the benefits of business partnerships and integration/cooperation for profitable and competitive expansion, especially for medium to small businesses.

Lem et al. (1994) asserted that as far as the fish marketing chain is concerned, it is recommended that governmental institutions and NGOs should play an active role in the improvement of the vertical fish marketing chain. Their cooperation with the private-sector stakeholders is requested as capabilities of the private sector to establish well-working cooperation arrangements seem limited and have not (yet) brought the expected benefits. Thus public/private partnership appears to be the key to success. According to the most recent development program (2001-2006), the government seemed to address this issue, with the promotion of the so called “cadenas de valor” (value webs) of the industry. However, the program is comprehensive and perhaps more complicate and ambitious than previous programs, thus it might take some time before some sorts of results are noticed.

Unlike former state cooperatives that are widely discredited because of their poor performance and high cost, key design principles are organisations that are voluntary, economically viable, self-sustaining, self-governed, transparent, and responsive to their members. Supporting these kinds of organisations will require government and donor support, engaging with businesses and civil society groups. Producer-based organisations will need help in developing businesses and management skills, establishing information systems and connections to domestic and global markets, creating good governance practices, and creating the infrastructure to connect small farmers to finance and input supply systems.

Public policy can help ensure improved market access for small farmers by putting in place institutions to deliver finance, reduce risk, build social capital, of producers and traders, transmit market information, grade and certify goods, and enforce contracts (Gabre-Madhin, 2001). Infrastructure investments are also crucial; the farmer least likely to benefit from globalising markets are those who are more distant from roads and markets (Narayanan et al., 2003).

6.2 Conclusions

Tilapia farming in Mexico has not developed as fast as it could be expected. Especially when considering its huge potential through a strong domestic market, trade partnership and close proximity with one of the largest export markets for tilapia products (i.e. USA), suitable environmental conditions in most of the country, cheap labour and appropriate technology available. Situation that makes questionable whether its competitiveness and profitability are completely evident within businesses, particularly among medium to small farms. The study has identified a number of key issues:

Farmed tilapia represents a small share of the domestic market, as most of the supply of tilapia comes from the catching sector and imports (91.3 and 7.3% respectively); with Mexican aquaculture contributing only with 1.3% of the country's supply. The weak contribution of the tilapia aquaculture industry is because the large majority of production (85%) is done by small independent operations (<100 t yr-1), with small and inconsistent outputs. There was a generalised poor awareness of efficient strategies to promote competitiveness amongst tilapia farmers, as the benefits of marketing strategies, business partnerships and/or integration were poorly understood and promoted in Mexico. Only a few cases were found within the tilapia aquaculture industry in Mexico, though were among the most successful cases.

The domestic market of tilapia in Mexico is experiencing major changes in relation to supply availability (with reduced outputs from the catching sector and increase presence of imported products), types of products traded, range of prices, distribution channels employed, and perception of the product. However, there was an unlawful competition from imported products as they were mostly produced in China and traded frozen, but enter the country via US and Canada to avoid taxes through NAFTA, and in many occasions were thawed and traded as fresh, without stating the country of origin.

Farmed products in small and medium businesses showed an evident price and profits disadvantage compared to other sources. Production costs of tilapia in Mexico were 50% higher than other major producing countries, represented mainly by feed, labour, electricity/water and fingerlings. At the source level (i.e. fisheries, importers and farmers), wild and imported tilapia products were about 4 and 2 times cheaper than farmed tilapia respectively. Therefore, the farming industry in Mexico will require to develop strategies to reduce these major input costs to become more competitive. Additionally, the lack of differentiation of farmed tilapia compromised its profitability, as many wholesalers and retailers traded all tilapia products undifferentiated from their source.

There was a common perception of an inefficient legal framework regulating the industry, as the legislation of aquaculture in Mexico is complex, voluminous and fragmented among numerous enactments, and sometimes governed by a number of overlapping laws and regulations that fall under the jurisdiction of several different agencies. Legal uncertainty for land and water usage for aquaculture purposes, including federal owned areas (i.e. all water bodies and their respective shores) deter investors from aquaculture. The regulation of processing and trading seafood products were focused on human health aspects, portraying the effort from the government to reassure a healthy and hygienic food supply in the country, a particularly sensitive issue when dealing with any seafood product. However, more needs to be done to ensure a proper monitoring of these sectors and the compliance of the regulations, as the industry could face serious drawbacks if few mismanagement experiences get generalised to the rest of the industry. As a result, there was a wide spread incidence of informal and illegal activities within the industry; the lack of understanding and affinity between producers, traders and policy makers have driven businesses to operate informally, thus resulting in many occasions in large quantities of tilapia products traded unreported and/or illegally.

Until recently, most of the governmental efforts to develop tilapia aquaculture in the country were mainly focused towards the production of food for social purposes (subsistence activities), neglecting the commercial farming potential and marketing requirements of the industry. Hence the larger proportion of small businesses present today. Although recent development and support programs have been designed with a more holistic approach, their success have been hampered by the institutions common problems and inefficiencies; i.e. the lack of coordination between the different institutions, excessive bureaucracy, different legal framework imposed on every new government elected, insufficient and delayed funding schemes, lack of experience of extension staff, information difficult to reach and corruption (i.e. high concentration of support in just a few producers, use of the resources for political purposes and bribery). Poor development programs and diffusion of appropriate farming techniques for tilapia has resulted in a great disparity of the techniques employed amongst businesses with similar conditions. This made it difficult for farmers to share experiences and compare results, therefore, be able to define the most suitable and profitable ways to farm tilapia within a certain region and conditions, contributing to its slow development. Additionally, the majority of tilapia farmers had little experience (80% had <5 yr), scores of projects were struggling with the learning curve. Appropriate consultancy was difficult to access, as the more experienced farmers were reliant to share their knowledge and governmental extension workers commonly have little experience if any.

There was also little interest and poor performance from private and governmental financial institutions towards fish aquaculture and their marketing activities. In which only a small proportion of the annual budget for aquaculture and fishery industry development was dedicated to fish farming and marketing activities (around 1% for fish farming and 6% for marketing activities), with major beneficiaries shellfish culture, processing and fisheries. As a result, a large proportion of tilapia farmers still get financed through their own economic resources (almost 60%), while governmental institutions and private banks financed (mostly partially) only 40% and 3% of the businesses respectively.

Nevertheless, the tilapia aquaculture industry in Mexico proved to have considerable scope for profitable expansion by producing competitive quality products through active public/private sector development. As the tendency in the last decade showed an expansion of more commercial activities in both social and private sectors, encouraged by a large domestic demand of quality fresh products, the increase of governmental development programs and private investment, and the availability of new technologies. The study found a range of issues in relation to production, marketing and business environment that could help to develop the tilapia industry in Mexico, including:

Reduction of production costs and promotion of profitability by efficient use of resources (including man power) and increase outputs through the adoption of appropriate technologies, polycultures, integration (with other agricultural activities and similar business), economies of scale, and public/private partnerships/co-operations.

Feed costs were significantly reduced through on-farm production of feed employing locally available cheap ingredients, maximisation of feed usage by implementing polycultures and integrated aquaculture, strict control and adoption of appropriate techniques for feed administration, partnership with feed plant for regional distribution and constant testing of the feed used and challenge with different feed brands assessing cost-effectiveness. Electricity and water costs on the other hand, were reduced through integrating with agriculture and livestock, as until recently, the aquaculture tariff was considerably higher than for the other two. Significant reductions were achieved also by using electricity generators based on renewable sources (i.e. solar, wind and water), and strict control and employment of energy-efficient equipment. Whereas fingerling costs were cut considerably by producing the seed by themselves, as price of fingerlings have been on the rise due to the recent decision of some of the major governmental hatcheries to sell. There were easy and cheap technologies to produce tilapia fingerlings already available in the country that can be readily adopted by small to medium producers.

Appropriate know-how and technology is already available in the country, with experienced farmers and research institutions employing and developing more efficient technologies, however, it is important to generate appropriate systems in which this knowledge could be spread along the industry more efficiently.

Strong and well developed co-operation and partnerships have proved to be important for development of the tilapia industry; as it has been the case of the catching sector with a fishermen-middlemen-wholesaler co-operation relationship, which had made transactions more reliable and secure. Whereas perhaps one of the most successful strategies followed by SME's was the horizontal and/or vertical integration, which allowed them to improve efficiency and competitiveness of their businesses through enhanced performance of individual farms and strengthening of the dealing power (for both, inputs purchase and outputs sell). Additionally, integration with other agro-activities (i.e. fisheries, shrimp farming, livestock and agriculture) proved also to be a successful strategy employed by some producers, were increasing number of entrepreneurs have been switching or adopting tilapia farming due to its comparable improved perception as a more feasible or profitable businesses.

Reduced outputs from the catching sector boosting the demand of fresh tilapia products, together with its improved perception due to increasing supply of imported products with superior presentations, have influenced a relatively stable price of tilapia products within the domestic market, promoting a more positive perception of the industry as more secure and predictable. However, strong seasonal demand (winter and spring) and defined periods for supply in some regions of the country (according to the fisheries regulations and location) have resulted in periodic increase in retailing prices (usually between 20 and 35%); representing at the same time, a great opportunity for farmers to increase profits if all or part of the harvest is programmed for these periods.

Increasing numbers of trading operators were opting for more processed and value-added products, with filleted products as the most popular. Around 70% of wholesalers and most retailers (90%) traded some sort of filleted products, contrasting with the predominant availability of tilapia in the gutted form only 20 years ago. This suggest the changing trend in the way tilapia is traded and consumed in Mexico, now opting for more presentations easy-to-eat / easy-to-cook, especially in major cities, were time and practicality were factors of prime importance when purchasing seafood products. Additionally, there has also been growing interest for frozen and well packed products, mainly due to their practicality for handling, storage and trade; but also because of the almost inexistent quality loss through the marketing chain, particularly appealing to wholesalers and supermarkets. Moreover, large trading companies (i.e. supermarkets) had also showed increasing preference for certified products, as quality reassurance has become key factor for trade in this sector, especially in relation to seafood products, comparably perceived as more prone to cause health risks. This contrast with the generalised production of tilapia by farmers in the less processed forms (mainly gutted), suggesting the need for producers to move towards more specialised products, though these strategies are more feasible to be adopted by medium to large producers.

The supply of particular products by major sources (i.e. fisheries and imports), suggests the emergence of potential niche markets for tilapia farming, in particular the production of medium to large fresh fillets. Which apart of allowing the producer to sell 3 times more of live-weight produce (typical yields of 35%); showed a large demand within the domestic market, attractive selling price (up to 60% higher than small fillets) and compared to other presentations, less competition from other sources (in size with the fisheries and freshness with imports) and more versatile to compete in more lucrative niche markets (specially with supermarkets and restaurants).

If competitive production costs of farmed products are achieved, the involvement of less marketing operators to reach retailing businesses will represent greater profits for each player implicated, allowing also full control of transactions with less complicated deals. These conditions could help to expand to new markets like food service businesses, i.e. caterers, restaurant chains, traditional restaurants and fast food, which are under-targeted by major sources, and normally would require products available locally, in constant supply, fresh and able to ensure its quality.

6.3 Recommendations

There are concerns about the profitability and competitiveness of tilapia farming in Mexico. For farmers, the lack of knowledge of proper farming techniques and marketing strategies may have an effect on profitability and on the ability to achieve quality standards to reach key markets. A range of major production, marketing and business environment issues may be important for development of tilapia farming including:

Improvement of husbandry skills and reduction of production costs: Farmers need to extend their basic knowledge, develop better skills in tilapia cultivation compatible with local resources and adopt more efficient technologies. Special efforts should be placed on reducing production costs as it represents the main weakness of many tilapia farms in Mexico. Training and extension services could help considerably to improve profitability and risks. According to the research, key areas to improve are fingerling production, feeding, diseases, stocking densities and water quality; although better ideas of suitable input levels for best returns in specific conditions are required, ideally reducing heavy expenditure on feed and electricity. This could be achieved by establishing as common practice the constant and careful monitoring of costs and performance of equipment and techniques employed, so they could be assessed and compared with similar businesses.

Promotion of efficient business organisations: A critical issue is to get farmers to view tilapia farming as a commercial activity with profitable potential, instead of merely a subsistence activity or an agri-business of poor returns. Most of the tilapia farms in Mexico operate individually, resulting in many occasions in competition between each other for the same markets, and commonly driving the smaller or weaker out of business. Similarly, as the majority of farms are of small scale, outputs are small and inconsistent, placing them in great disadvantage from larger producers and other major sources, i.e. fisheries and imports. Therefore, greater efforts are required to promote economies of scale, integration, partnerships and co-operations with other agro-activities and related businesses in both directions of the industry (horizontal and vertical). Like this, businesses can improve efficiency and profitability through lower costs and larger outputs, increase competitiveness and technology transfer, and boost the interest from related businesses due to stronger dealing power (i.e. inputs suppliers and customers) and from support institutions (i.e. research, development and financial institutions). This could be done by promoting the creation of regional associations of producers, in which major issues could be discussed and successful experiences could be shared, as well as developing partnerships in all or some part of the activities involved in the business (e.g. bulk purchase of inputs for all the members of the association). Additionally, development institutions should promote close relationships between successful integrated businesses and groups of SME's to encourage their association in partnerships, as commonly results more convincing to be able to experience the potential of such type of business organisation than merely theoretical descriptions.

Employment of better marketing strategies: Better approaches to target key markets are required, including types of products traded, market targeted, seasonality and distribution. Value-added products were crucial to access profitable markets. Although small farms could normally fetch good profits by targeting the final consumer offering products with little processing involved (i.e. live or gutted) and/or more processed products like ready-to-eat or cooked (e.g. fried); medium to large businesses need to focus their efforts towards less competed marketing niches, improve perception of their products and differentiate them from other sources.

This could be done by targeting products exploiting some of the mixed characteristics highly appreciated from competing products, and at the same time avoiding direct competition, as it could be in the case of producing medium and large fresh fillets; tacking advantage of the freshness from wild products and large sizes and good presentation of imported products. However, after all has been said, the buying and selling of tilapia is a commodity market. Much like other food items such as produce and meat, price is affected not only by supply and demand, but also by marketing techniques, quality, value, and perceptions. Variations in price may be quite dramatic between sizes of tilapia. Therefore, it might be best for farmers not to lock themselves into a particular size, but to ask their clients for the price willing to pay of the size just above and just below the size the farmer wants to produce. It is often more simple to move up or down a size and realise considerable profits; similar with different products (i.e. gutted-scaled, head-off, gills-off, deep-skinned fillet, etc.) or presentations (fresh, frozen, individually vacuum-packed, boxes of 20 kg, etc.), but it would be advisable to first clearly understand if the production of these products would fit the operation and its limitations.

Additionally farmers should also be encouraged to target retailing business, in particular those sectors less targeted by competing sources, i.e. supermarkets, caterers and food services; as they normally would also purchase in large volumes and have preference towards products with quality reassurance; a situation that is easy to adopt through farming. Thus, large volumes could also be traded whilst fetching better profits. Moreover, farms could attain better profits by targeting their production or part of it to high seasons (i.e. spring and winter, but specially Easter) and/or Southern and Coastal areas. In the former, high demand of tilapia products during these seasons result in price increases of up to 50%; whereas in the latter, northern and central regions are highly targeted by competing sources and are more used to frozen products, while coastal and southern regions tend to show a greater appreciation for the specie and freshness is of prime importance. And finally, it should be encouraged to trade farmed tilapia products differentiated form the other sources, by employing and promoting names like "tilapia de granja" (farmed tilapia), and develop brand loyalty, but avoiding deceiving the consumer by using other names, e.g. "blanco del nilo/oriente" (white from the nile/east), mojarra and pargo (snapper).

Effective regulation of the industry: There is a need for simplification, expansion, up-date and enforcement of suitable regulation schemes to match the actual needs of the industry and its requirements for further sustainable development. The aquaculture legislation in Mexico needs to be simplified, made more user-friendly, inclusive and continuous with all the issues related to the activity, and set up in a way that avoids overlapping with other regulations and/or falling under the jurisdiction of several different agencies. This might promote its compliance within businesses of different levels.

Additionally, aquaculture and seafood trade legislation need also to be inclusive of species equally important for the country (i.e. tilapia), and not only focus on species with higher economical value (i.e. shrimp and tuna). Constant assessment of the actual needs of the industry and faster official approval of the policies should be encouraged within regulatory bodies, so the industry adapts more accurately and efficiently to the rapid changes and trends that might exist. Special efforts should be placed towards the enforcement and monitoring of regulations, in particular hygienic and health monitoring and information provided of the products, especially the country of origin and source; were trade tariffs should be enforced to products produced outside NAFTA. Special interest should be placed towards defining land and water ownership, especially in federal-owned areas.

Improve the organisation and efficiency of development institutions: Greater efforts should be placed towards more efficient development programs, as these might be more inclusive of related activities and more skills-demanding. These efforts should focus on promoting better coordination between institutions, monitor their performance and achievement of goals, reduce excessive bureaucratic procedures, eliminate corruption, supply suitable and prompt support, include proper training of extension staff, facilitate the availability of information and reassure the continuation of the programs in future elected governments. Technology transfer programs could be improved by promoting regional associations of producers, which could help to bring producers closer and allow a more fluid exchange of requirements, experiences and knowledge. Producers need to be able to fully understands and be aware of the tools and schemes available, while development institutions need to clearly understand the needs of the industry. This will allow support and development efforts to reach the targeted sector in an efficient manner.

Improve access of credits to farmers and the industry in general: Better coordination and efficiency of financial institutions would be required as credits very often result difficult to reach. Additionally, the relevance of tilapia farming in financing schemes in Mexico should be greater and equalised with other species like shrimp. These schemes should include the development of more projects within the industry (i.e. production, processing and trade). These two issues could be addressed through promoting closer relationships between lenders and businesses, offering incentives to private banks for financing the industry to attract more institutions and reduce the level of risk perceived of the industry. This could be further promoted by improving extension and consultancy efforts towards production, marketing and credit access to improve efficiency; and making available low-interest credits supported by governmental institutions to ease the dept burden and reduce the risks for medium and small farmers.

6.4 Further research

Although this study described and analysed the most suitable strategies required to develop the tilapia aquaculture industry in Mexico; aiming to promote its competitiveness, profitability and support. Some areas were found to require further research such as:

The exploration and definition of the most suitable and profitable technologies (including species, husbandry and systems) required for tilapia farming, in relation to the different conditions available in the country (e.g. its climate, geography, local demand, etc.). As in some areas producers and extension services were not yet clear on the best options.

Research on efficient processes and promotion strategies for the adoption of business partnerships and co-operations should also be given special attention, especially for the promotion of the development of small and medium producers.

There is also a need to research the real competitive advantage and the feasibility to adopt and implement value-added attributes to the business and products, like quality certifications (HACCP and ISO), organic tilapia and fair trade. As they could be strategic to enter key niche markets, their cost-effectiveness needs to be explored.

Further research would also be needed to produce more reliable and up-to-date data in relation to trends and market behaviour of fisheries and imported tilapia products, as official data was fractioned and confusing, affecting the clarity of the constant and up-to-date analysis of the tilapia market in Mexico. Considering the lack of information services among producers, input suppliers, marketing operators, and development institutions, the establishment of an information network needs to be addressed.

It would also be of great interest to explore the marketing strategies most suitable and feasible for particular conditions, involving not only tilapia farming, but also other sector of the marketing chain. As in general, very few businesses had a clear idea and understanding of the strategies available to tackle a particular situation.

Research needs to be done on efficient and feasible processing techniques and value-added products suitable for SME's, taking into account the existing technology, the transfer, adaptation, development of new technology, and more importantly, the market trend.

Research on suitable regulations for actual trends in the industry to promote its sustainable development needs to be considered. Similarly, further research is required for better monitoring and efficiency of actual development and support programs, as well as on suitable financing schemes for both lenders (including private banks and moneylenders) and receivers.

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Appendix

Appendix 1 Hydrological description of major rivers in Mexico, by emptying point (CNA, 2005).

		Mean surface runoff (hm^3)	Area of the basin (km^2)	Length of river (km)
	Inland Rivers			
1	Lerma	4,908	47,116	708
2	Nazas	1,999	57,101	600
3	Aguanaval	509	32,138	481
	Rivers that empty into the Golf of Mexico			
4	Grijalva-Usumacinta [b]	115,536	83,213	1,521
5	Papaloapan	44,662	46,517	354
6	Coatzacoalcos	32,752	17,369	325
7	Pánuco	19,087	84,956	510
8	Tonalá	11,389	5,679	82
9	Bravo [b c]	7,398	226,280	2,018
10	Tecolutla	6,885	7,903	375
11	Tuxpan	2,580	5,899	150
12	Nautla	2,284	2,785	124
13	Antigua	2,193	2,827	139
14	Soto La Marina	2,086	21,183	416
15	Candelaria [a b]	2,011	13,790	150
16	Cazones	1,716	2,688	145
17	San Fernando	876	17,744	400
	Rivers that empty into the Pacific Ocean			
18	Balsas	24,273	117,406	770
19	Santiago	7,849	76,416	562
20	Verde	5,937	18,812	342
21	Ometepec	5,779	6,922	115
22	El Fuerte	5,176	33,590	540
23	Papagayo	4,237	7,410	140
24	Yaqui	3,623	72,540	410
25	San Pedro [b]	3,559	26,480	255
26	Culiacán	2,912	15,731	875
27	Suchiate [a]	2,737	203	75
28	Ameca [b]	2,020	12,214	205
29	Armería [b]	2,015	9,795	240
30	San Lorenzo	1,885	8,919	315
31	Coahuayana [b]	1,867	7,114	203
32	Colorado [a]	1,867	5,180	179
33	Sinaloa	1,829	12,260	400
34	Baluarte	1,751	5,094	142
35	Acaponeta	1,329	5,092	233
36	Piaxtla	1,288	11,473	220
37	Tehuantepec	950	10,090	240
38	Coatán [b]	751	605	75
39	Huicicila	591	1,194	50

Source: Gerencia de Aguas Superficiales e Ingeniería de Ríos. SGT. CNA.
Notes: Data on mean surface runoff represents the mean annual figure in all records existing for it.
a: Mean surface runoff includes imports from other countries.The area of the basin and its length refer only to the portion in Mexico.
b: Preliminary data. Studies on these rivers have not been completed.
c: Length of the border between Mexico and the United States of America.
hm^3: cubic hectometre. 1 hm^3 = 1,000,000 m^3

Appendix 2 Description of major lakes in Mexico (CNA, 2005).

	Name	Area of the Lake's basin (km^2)	Storage capacity (hm^3)	Location (State)
1	Chapala	1,116	8,126	Jalisco and Michoacán
2	Cuitzeo	306	920*	Michoacán
3	Pátzcuaro	97	550*	Michoacán
4	Catemaco	75	454	Veracruz
5	Yuriria	80	188	Guanajuato
6	Tequesquitengo	8	160*	Morelos
7	Nabor Carrillo	10	12*	México

Source: Gerencia de Aguas Superficiales e Ingeniería de Ríos. SGT. CNA.
Note: *Data refers to mean volume stored; up-to-date studies are still not available on their storage capacity.

Appendix 3 Description of major reservoirs in Mexico (CNA, 2005).

	Official Name	Common Name	Total Capacity * (hm^3)	Location (State)	Purpose
1	Dr. Belisario Domínguez	La Angostura	10,727	Chiapas	G
2	Nezahualcóyotl	Malpaso	9,605	Chiapas	G
3	Infiernillo	Infiernillo	9,340	Guerrero-Michoacán	G, F
4	Presidente Miguel Alemán	Temascal	8,119	Oaxaca	G, F
5	Solidaridad	Aguamilpa	5,540	Nayarit	G, I
6	Gral. Vicente Guerrero C.I.N.	Las Adjuntas	3,900	Tamaulipas	I, P
7	Internacional La Amistad	La Amistad	3,887	Coahuila-Texas	G, I, P, F
8	Internacional Falcón	Falcón	3,273	Tamaulipas-Texas	P, F, G
9	Adolfo López Mateos	El Humaya	3,072	Sinaloa	G, I
10	Álvaro Obregón	El Oviachic	2,989	Sonora	G, I
11	Plutarco Elías Calles	El Novillo	2,925	Sonora	G, I
12	Miguel Hidalgo y Costilla	El Mahone	2,921	Sinaloa	G, I
13	Luis Donaldo Colosio	Huites	2,908	Sinaloa	G, I
14	La Boquilla	Lago Toronto	2,903	Chihuahua	I
15	Lázaro Cárdenas	El Palmito	2,873	Durango	I, F
16	José López Portillo	El Comedero	2,250	Sinaloa	G, I
17	Gustavo Díaz Ordaz	Bacurato	1,860	Sinaloa	G, I
18	Carlos Ramírez Ulloa	El Caracol	1,414	Guerrero	G
19	Manuel Moreno Torres	Chicoasén	1,376	Chiapas	G
20	Ing. Fernando Hiriat	Zimapán	1,360	Hidalgo-Querétaro	G
21	Venustiano Carranza	Don Martín	1,313	Coahuila	I, P, F
22	Miguel de la Madrid	Cerro de Oro	1,250	Oaxaca	G, I
23	Cuchillo-Solidaridad	El Cuchillo	1,123	Nuevo León	P, I
24	Ángel Albino Corzo	Peñitas	1,091	Chiapas	G
25	Adolfo Ruiz Cortines	Mocúzari	950	Sonora	G, I
26	Benito Juárez	El Marqués	947	Oaxaca	I
27	Marte R. Gómez	El Azúcar	824	Tamaulipas	I
28	Sanalona	Sanalona	740	Sinaloa	G, I
29	Solís	Solís	728	Guanajuato	I
30	Lázaro Cárdenas	La Angostura	703	Sonora	I, P
31	Constitución de Apatzingán	Chilatán	601	Jalisco	I
32	Estudiante Ramiro Caballero	Las Ánimas	571	Tamaulipas	I
33	José María Morelos	La Villita	541	Michoacán-Guerrero	G, I
34	Josefa Ortíz de Domínguez	El Sabino	514	Sinaloa	I
35	Cajón de Peña	Tomatlán	467	Jalisco	I
36	Chicayán	Paso de Piedras	457	Veracruz	I
37	Hermenegildo Galeana	El Gallo	441	Guerrero	G
38	Tepuxtepec	Tepuxtepec	425	Michoacán	G, I
39	Valle de Bravo	Valle de Bravo	418	México	P
40	Ing. Aurelio Benassini Vizcaíno	El Salto	415	Sinaloa	I
41	Manuel M. Diéguez	Santa Rosa	403	Jalisco	G
42	Francisco Zarco	Las Tórtolas	365	Durango	F, I
43	Ing. Luis L. León	El Granero	356	Chihuahua	I, F
44	Plutarco Elías Calles	Calles	350	Aguascalientes	I
45	Francisco I. Madero	Las Vírgenes	348	Chihuahua	I
46	Manuel Ávila Camacho	Valsequillo	304	Puebla	I
47	Ing. Guillermo Blake Aguilar	El Sabinal	300	Sinaloa	F, I
48	José López Portillo	Cerro Prieto	300	Nuevo León	P, I
49	Vicente Guerrero	Palos Altos	250	Guerrero	I
50	Gral. Ramón Corona Madrigal	Trigomil	250	Jalisco	I
51	Federalismo Mexicano	San Gabriel	247	Durango	I, P

Source: Gerencia de Aguas Superficiales e Ingeniería de Ríos. SGT. CNA.

Notes: * Total capacity refers to the storage at normal storage elevation.

G = Generation of electric power. I = Irrigation. P = Public supply. F = Flood contro

Appendix 4 Questionnaire employed on tilapia producers.

Date: …………………………..

Business Name: ……..………………………….…………………………………….
………………..………………………….…….……….…………….…………………

Location (County) (State): …………………………………………………………….
………………..………………………….…….……….…………….…………………

Georeference :

Sector : ……………………… (UTM)……………………… E / W

Altitude : …………………….. M (UTM) …..………………… N / S

Interviewee Name: ……..…………………………………………….…….………….

What is your relationship with the business?……………………………………….
………………..………………………….…….……….…………….…………………

TECHNOLOGY & SYSTEM MANAGEMENT

1 For how long have you been farming tilapia? ……………………………………………

2 What type of infrastructure is used for raising tilapia?

	units	m^2 / %
Earth Ponds:		
Tanks:		
Raceways:		
Recirculating Aquaculture Systems:		
Cages:		
Enclosures:		

Other (please specify): ……….…………………………………………………………

3 Total size of the farm (ha):.……..…………………………………………………….

4 Do you produce your own fry? (yes/no): [ ]

If not, where do they come from?...…………………………………………………..
………………..………………………….…….……….…………….…………………

5 Do you grow monosex tilapia? (yes/no):

If not, Why?: ……………………………………………………………………………………

6 How often do you input stock?……………………………………………………………
………………..………………………………………………………………………………

7 What is the length of the culture cycle?: ……….…………………………………………

8 What is the source of water?

	Vol.	%
Well		
River		
Lake		
Estuary		
Sea		

Other (please specify): ……………………………………………………………………

9 What services do you have? (mark accordingly)

Electricity	
Gas	
Tap water	
Roads	
Public transportation	
Telephone	
Internet	

10 What type of feed is used for raising tilapia?

	Kg.	%
Commercial Feed		
Home Made		
Natural feed		

Why?: ………………………………………………………………………………………

11 What Food Conversion Ratio (FCR) do you get in your farm?: ………………………

12 Total annual production of Tilapia (t): ……... …………………………………………

13 How much has your production output increased since you started?……..……...%

PROCESS

14 How do you harvest the fish?: ……………………………………………………………
……………………………………………………………………………………………

15 How is the product handled after harvest?: …………………………………………….
……………………………………………………………………………………………

16 Do you process your product? (yes/no): [ ]
If yes, How?: ……………………………………………………………………………

17 Is the product graded prior to selling? (yes/no): [ ]
If not, why?: ………………………………………………………………………….
If yes, how?: ………………………………………………………………………….

18 What product size do you sell:

	Kg.	%
Small (<250gr)		
Medium (~500gr)		
Large (>750gr)		

Other (please specify): ……………………………………………………………….

19 What influenced your decision to sell a particular product form? (please enumerate in relation to degree of relevance; i.e. 1 = most important)

Feasibility	
Yield	
Price	
Demand	

Other (please specify): …………………………………………………………………

20 Have you always sold the same product form? (yes/no): [ ]
If not, what other products and why did you change?:…………………………………
……………………………………………………………………………………………

TRADE

21 Where do you sell your tilapia:

	No. of Clients	Kg. / %
Processor		
Wholesaler		
Fishmonger		
Restaurant / Caterer		
Export		
Consumer		

Other (please specify): ……….………………………………………………………….

22 Why do you sell to those clients? ...…………………………………………………..
………………...…………………………………………………………………………….
………………...…………………………………………………………………………….

23 What percentage of sales are:

	%
Repeat business:	
New business:	

24 Do you find difficult to get new clients? (yes/no): [ ]

If yes, why? ..………………………………………………………………………………

25 Geographically, Where do you sell your product?

	Kg.	%
Local Market		
Regional Market		
National Market		
Export Market		

26 Who transport the product to your customers?

	Kg.	%
Client		
Yourself		
Transporter		

27 How is the product transported?: ……..……………………………………………….
………………...…………………………………………………………………………….
………………...…………………………………………………………………………….

28 How often do you harvest? ………………………………………………………………

29 Is there high season for trading tilapia? (yes/no): [ ]

If yes, when? ……………………………………………………………………………..

30 How does the price change during high season?: ..…………………………………….
………………..………………………….………………………….………………………

31 What percentage of your annual production do you sell: ………………………….%

32 What marketing strategy do you use to boost tilapia sales (i.e. product form, price, promotion and distribution): ..………………………………….…………………………
………………..………………………….………………………….………………………

33 How has it changed from previous years?...………………….……….………………
………………..………………………….………………………….………………………
………………..………………………….………………………….………………………

34 Do you apply any type of certification? (yes/no):
(e.g. ISO 9000 / 14000, HACCP, Kosher, Secretaria de Salubridad, etc.)
If so, which one?...

35 If certified, which of your customers require certified tilapia products?: ………………
………………..………………………….………………………….………………………

36 How do you get informed on the actual situation of the tilapia market? (e.g. prices, volumes, type of products, sellers, potential clients, selling seasons, etc.): ……….
………………..………………………….………………………….………………………
………………..………………………….………………………….………………………

37 What is your selling price of tilapia (MX$ per kg)? ..…..………………………………

38 Does tilapia compete with other products? (yes/no):
If yes, which products? ……………………………………………………………………

39 What are the mayor changes in tilapia trade since you started? …………………….
………………..………………………….………………………….………………………
………………..………………………….………………………….………………………

40 Which one of the following do you think has the most influence on the price of farmed tilapia? (enumerate in order of relevance; i.e. 1 = most relevant)

Fisheries
Farmer
Processor
Wholesaler
Fishmonger
Caterer
Importer
Exporter
Consumer
Other (please specify): ……………………………………………………………………

ECONOMICAL - LEGAL

41 What type of support have you received from governmental institutions?: …………..
…………………………………………………………………………………………………

42 Do you find any regulation hinder the development of your farm? (yes/no)
If yes, which ones? ……………………………………………………
…………………………………………………………………………………………………

43 Source of income: (annual percentage) %

Tilapia
Other aquatic species
Agriculture
Livestock
business
Job
Other (please specify): ……………………………………………………………………

44 If you have other sources of income, how is tilapia compared in relation to:
Profitability? (more, the same, less):
Feasibility? (more, the same, less):

45 Do you receive any loans to culture tilapia? (yes/no): [ ]

If yes, please complete the following table:

Source of loan	Amount of Loan	Interest rate (%) per month	Observations
Moneylender			
Bank			
NGO			
Government			
Self-funded			

Other (please specify): ....……..…………………………………………………………

46 In case of getting loans from other sources than banks, why you did not get loans from them? (enumerate in order of relevance; i.e. 1 = most relevant)

Lack of information [ ]

Too much paper work (too bureaucratic) [ ]

High interests [ ]

High warranties required [ ]

Loan amount is too small [ ]

Other (please specify): ....……..…………………………………………………………

47 What are the main changes/improvements in tilapia farming since you first started?

………………..……………………………………………………………………………

………………..……………………………………………………………………………

48 What would you consider are the major problems that hinder the development of tilapia culture?: ……………………………………………………………………………..

………………..……………………………………………………………………………

49 Have you improved your economic condition on tilapia farming? (yes/no): [ ]

If no, why: ...……………………………………………………………..

………………..……………………………………………………………………………

Cost-return analysis of tilapia farming:

50 Cost analysis:

Items	unit	MX$/unit	Amount (MX$)
fry/fingerling			
Feed			
Fertilizer			
Labour			
Harvesting and Marketing			
Electricity			
Water			
Others			
Salary of management			
Staff			
Interest			
Depreciation			

Total

51 Revenue:

Items	unit	MX$/unit	Amount (MX$)
Tilapia			
Other			

Gross revenue

52 Net Return = Gross revenue ……..MX$ - Total costs ………..MX$ = …………MX$

53 Do you have any other comment in relation to tilapia production and trade?.............
………………………………………………………………………………………………..

Appendix 5 Questionnaire employed on marketing operators.

Date: …………………………..

Business Name: ..……...…………………………………………………………………
……….……………………….………………………………………………………………

Type of business (e.g. middlemen, importer, wholesaler, processor, supermarket, fishmonger and restaurant/caterer)?....…………………………………………………..

Location (County) (State): ..…...……………………………………………………….
……………..…………………………………………………………………………………

Georeference :

Sector : ……………………… (UTM) …...………………… E / W

Altitude : …………………….. M (UTM) …………………….. N / S

Interviewee Name: …..…..……………………………………………………………….

What is your relationship with the business?…..…………………………………………
……………..…………………………………………………………………………………

SUPPLY

1 Who supply you with tilapia?

	%	% Farmed
Farmer		
Fisheries		
Processor		
Trader		
Imports		

Other (please specify):…...……….………………………………………………………

2 Where does the product come from?

	kg	%
Locally		
Regional		
National		
Imported		

Other (please specify):……..…………………………………………………………………

3 Who transport the tilapia to your business?

	kg	%
Farmer		
Transporter		
Processor		
Trader		
Own-self		

Other (please specify):……..…………………………………………………………………

4 How is it the transportation carried out?:…..…………………………………………………

……………..……………………………………………………………………………………

……………..……………………………………………………………………………………

5 What is the presentation of the supplied tilapia? (in relation to):

Product form?:……..……………………………………………………………………………..

Size?:………………………………………………………………………………………………

Packing?:…….……………………………………………………………………………………..

6 Why you chose this presentation? (please enumerate in relation to degree of relevance; i.e. 1 = most relevant)

Product quality	
Yield	
Price	
Demand	
Supply	
Diversification	

Other (please specify):……..…………………………………………………………………

7 What other characteristics do you look for when buying tilapia for trade?..………..……

……………..……………………………………………………………………………………

……………..……………………………………………………………………………………

8 What price do you pay for the different tilapia products you buy? (MX$/kg):…….………
……………..……………………………………………………………………………………

9 How often are you supplied with tilapia products?..
……………..……………………………………………………………………………………

10 What percentage of suppliers are:

	%
Repeat business? (i.e. constant):	
New business?:	

11 Do you consider difficult to find new suppliers (yes/no)? [ ]
If yes, why?:…………………………………………………………………………………..

12 Do you apply further processing to the tilapia supplied (yes/no)? [ ]
If yes, what type?:……..…………………………………………………………………………
What yields do you obtain?: ....

13 What infrastructure do you have for tilapia trading (e.g. storage, transport, communication facilities)?: ....
……………..……………………………………………………………………………………
……………..……………………………………………………………………………………

14 Do you own the infrastructure or you rent it?...

15 Do you employ any certification scheme for the trade of tilapia products (yes/no)?
(e.g. ISO 9000 / 14000, HACCP, Kosher, Secretaria de Salubridad, EMA, etc.) [ ]
If yes, which one?:…..……………………………………………………
If not, why not?:…………………………………………………………………………………

SALES

16 In average, how many kilograms of tilapia do you trade annually/monthly/weekly/daily?:...

17 Can you supply your demand throughout the year (yes/no)? [ ]
If not, why?:……...……………………………………………………………………………

18 Who you sell your tilapia products to?

	No. Clients	kg / %
Consumer		
Wholesaler (middlemen/wholesaler)		
Fishmonger		
Restaurant (caterer)		
Processor		
Export		

Other (please specify):…....…………………………………………………………………

19 Is there any reason in particular of why you sell to those clients?...........……………

……………..………………………………………………………………………………

……………..………………………………………………………………………………

20 What percentage of your clients are:

	%
Repeat business? (i.e. constant):	
New business?:	

21 Do you consider difficult to find new clients (yes/no)? [ ]

If yes, why?:…………………………………………………………………………………..

22 What tilapia products do they buy (please specify form and size of the product)?…..

……………..………………………………………………………………………………

……………..………………………………………………………………………………

23 What do your clients look for when buying tilapia? (please enumerate in relation to degree of relevance; i.e. 1 = most relevant)

Price	
Size	
Availability	
Presentation	
Colour	
Shape	
Appearance	
Quality	
Freshness	

Other (please specify)…………..……………………………………………………………

24 Have you traded a different tilapia product previously (yes/no)? [ ]

If yes, what other products?:…………………………………………………………………

Why did you change?:………………………………………………………………………

25 What is the selling price for each of the tilapia products you sell?

Maximum (MX$/Kg):……………………………………………………………………..

Minimum (MX$/Kg):………………………………………………………………………..

Average (MX$/Kg):…………………………………………………………………………..

26 According to you experience, what is the best season for tilapia trading?………….

…………………………………………………………………………………………………

27 What percentage of your annual sales do you achieve during high season?………%

28 How much does price change during high season?……………………………………..

29 How much does price vary between farmed and wild tilapia?…………………………..

…………………………………………………………………………………………………

30 Geographically, were is your product distributed?

	kg	%
Local market		
Regional market (within the state)		
National Market		
Exported		

31 How is the product transported to your customers?………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

32 What marketing strategies do you use to boost tilapia sales? (please enumerate in relation to degree of relevance; i.e. 1 = most relevant)

Product type	
Price	
Promotion	
Distribution	

Other (please specify):……………………………………………………………………

33 Has your marketing strategy changed from previous years (yes/no)?

If yes, what did you used to do?..

……………..…………………………………………………………………………………

34 Which one of the following do you think has the most influence on the price of farmed tilapia? (enumerate in order of relevance; i.e. 1 = most relevant)

Fisheries

Farmer

Processor

Wholesaler

Supermarket

Fishmonger

Restaurant/Caterer

Exporter

Imports

Consumer

Other (please specify)………..……………………………………………………………

What type of support have you received from governmental institutions?:……………..

SUPPORT AND REGULATION

35 Do you receive any type of support from any governmental institution (yes/no)?

If yes, what type of support? (e.g. economic, educational, consultancy, inputs, equipment, etc.):………………………………………………………

……………..…………………………………………………………………………………

36 Do you find any regulations hinder the development of your business?:…………………

If yes, which one?...

……………..…………………………………………………………………………………

37 Have you received any loans for your trading business (yes/no)?

If yes, from who?..

38 If you took loans from sources other than banks, why do you choose not go to a bank? (please enumerate in relation to degree of relevance; i.e. 1 = most relevant)

Lack of information	
Too much official work (too bureaucratic)	
Credit not available	
Warranties required are too high	
Interest are high	
Loan amount low	

Other (please specify)………….………………………………………….……………………

ECONOMIC AND GENERAL CONSIDERATIONS

39 Do you trade other products (yes/no)? ☐

If yes, what other products?:…………………………………………….…………………….

……………..…………………….…………………………………….……………….………

40 Why did you choose to trade tilapia? (please enumerate in relation to degree of relevance; i.e. 1 = most relevant)

Quality	
Price	
Demand	
Supply	
Diversification	

Other (please specify)…..………..…………………………………….……………………

41 If trading other products, how is tilapia compared in relation to:

Profitability (more, the same or less)?:.…………………………………….……………

Feasibility (more, the same or less)?:.…………………………………….……………….

Quality (more, the same or less)?:…………………………………….…………………..

42 For how long have you trade:

	Years
Other products?:	
Tilapia?:	

43 Source of income: (annual percentage)

	$	%
Tilapia		
Other products traded		
Agriculture and/or livestock		
Other Business		
Job		

Other (please specify)……..……..………………………………………………………………

44 Does tilapia compete with other products (yes/no)?:

If yes, with which ones?:………………………………………………………………………

……………..………………………………………………………………………………………

45 What would you consider are the major factors that have improved the trade of tilapia products since you first started? (e.g. volume, presentation, price, distribution, etc.):..

……………..………………………………………………………………………………………

46 What would you consider are the major problems hindering the trade of tilapia in Mexico since you first started?:………………………………………………………………

……………..………………………………………………………………………………………

47 Have you improve your socio-economic condition on tilapia trading (yes/no)?

If not, why?:……………………………………………………………………..

……………..………………………………………………………………………………………

Do you have any further o

48 Do you have any other comment in relation to tilapia trade and production?...............

……………..………………………………………………………………………………………

Appendix 6 Questionnaire for institutions and businesses related to the tilapia industry.

Date: ……………………………..

Name of the Institution u Organization: ..…………………………………………………….
……..……………………………………………………………………………………………

Type of institution (e.g. Governmental: federal/state/municipality; Private: financer, consulter, supplyier, ngo, etc.): ………………………………………………………………
……..……………………………………………………………………………………………

Location (Municipality, State): ………………………………………………………………..
……..……………………………………………………………………………………………

Name of the interviewee: ……………………………………………………………………….

1 What is your relation with the Institution/organisation?: …..
……..……………………………………………………………………………………………

2 For how long have you been involved in the institution?:……………………………………

3 What is the role of the institution/business in tilapia production/trade?: .....……………
……..……………………………………………………………………………………………
……..……………………………………………………………………………………………

4 How important is the tilapia industry for the institution/business?: ....
……..……………………………………………………………………………………………
……..……………………………………………………………………………………………

5 What is the perception of the institution/business of the importance of the tilapia aquacultre industry for Mexico's agri-industry development?: …………………………….
……………………………………………………………………………………………

6 How does the institution/business been involved in the development of the industry?: …
……………………………………………………………………………………………
……………………………………………………………………………………………

7 What do you consider are the major improvements of the tilapia aquaculture industry in Mexico?: ……………………………………………………………………………….
……………………………………………………………………………………………
……………………………………………………………………………………………

8 What do you consider are the major problems hindering the delopment of the tilapia aquaculture industry in Mexico?: ………………………………………………………….
……………………………………………………………………………………………
……………………………………………………………………………………………

9 What is the current policy and the future trend of your sector to tackle those problems?
……………………………………………………………………………………………
……………………………………………………………………………………………

10 What other institutions/businesses within the sector are involved in tilapia aquaculture and trade?: ………………………………………………………………………………….
……………………………………………………………………………………………

Regulatory Institutions

11 How are the regulation/development/support schemes applied to the industry?: ……….
……………………………………………………………………………………………
……………………………………………………………………………………………

12 How are these regulations/development/support schemes monitored?........................
……………………………………………………………………………………………
……………………………………………………………………………………………

13 What is the impact of these regulations/development/support schems in the development of the tilapia industry in Mexico?: ……………………………………………………..
……………………………………………………………………………………………………
……………………………………………………………………………………………………

14 What do you do to make sure the industry aware of these regulations/development/ support schemes?: ………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

Financing Institutions

15 What can be done to allow tilapia farmers reach credits from private banks?: ………….
……………………………………………………………………………………………………
……………………………………………………………………………………………………

Feed Companies and Equipment Suppliers

16 What are the main items/products consumed by your clients?: …………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

17 How is your company coping with the general perception of tilapia farmers of the relative high cost of feeds/equipment?: ………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

Appendix 7 Initial introduction to the interviewee.

Ice-breaking and introductions
Thanks for agreeing to meet me
Weather
Comments on local area
Background to the study
Introduction of me as a PhD student of the University of Stirling.
The project is funded by the Department for International Development (DFID) in UK, The National Science and Technology Council (CONACYT) in Mexico, and the University of Stirling in Scotland; commissioned to undertake research on production and trade constraints of farmed tilapia with the aim to develop the industry.
Industry Segment
We are interviewing a wide range of key players involved on the production and trade of tilapia. That this segment/player of the tilapia industry is clearly an important segment, and that we would like to contact some of the main operators in that sector.

Appendix 8 Advantages and disadvantages of sole proprietorship in a business (Kholer 1993).

<u>Sole Proprietorship</u>

Advantages

+ Most private farms in Mexico are sole proprietorship.
+ The farmer is the sole owner, has legal title to the property and is self employed.
+ Management decisions are solely under the control of the farmer.
+ Resources for the operation are limited to that available to the sole proprietor.
+ Sole proprietorship is the simplest form of business organization as far as start-up and record keeping are concerned,
+ If the farm operation will cease upon the death of the sole proprietor, it is the simplest structure to liquidate.

Disadvantages

+ With this organizational structure, personal and business assets of the owner are jointly at risk in the operation
+ Liability is not limited to only that which is invested in the business. The farmer has total liability for all payments or actions, whether incurred personally or through the farm business.
+ Sole proprietorship has been described as a hindrance to estate planning, farm transfer and farm efficiency

Appendix 9 Advantages and disadvantages of partnerships in a business (Kholer 1993).

Partnerships

Advantages

+ Most farms belonging to the social sector tend to be arranged in partnerships (production cooperatives).
+ Consists of two or more persons as co-owners.
+ In agriculture, parent/child partnerships have been popular
+ Each partner shares in the ownership, management and liability of the farm business
+ The individuals, not the partnership, are the taxpayers
+ The main advantage of the partnership arrangement is the increase in resources brought to the business as additional partners enter into the operation.
+ The general partner views the limited partner as an additional source of resources without the obligation of sharing management decisions.
+ The limited partner's risk and liability are only to the extent of their investment in the business. The limited partner is essentially trading a voice in management for limited liability.

Disadvantages

+ With the increase in resources, comes a loss of total management control.
+ If a partnership is dissolved, property transfer becomes complicated.
+ Generally, profits are not equally shared among general and limited partners in a limited partnership. The general partners are normally paid a salary for managing the operation, and the remaining profits are proportionally distributed

Appendix 10 Main regulations (NOM) involved in the production of tilapia in Mexico, including fisheries and aquaculture (DOF, 2005).

NOM Code	Definition	Institution
NOM-009-PESC-1993	Procedure to determine the close seasons and zones for the capture of various species of aquatic flora and fauna in Mexico	SAGARPA
NOM-010-PESC-1993	Establishes the health requirements for the importation into Mexico of alive aquatic organisms at any development stage for aquaculture or ornament.	SAGARPA
NOM-011-PESC-1993	Regulates the application of quarantines to imported live aquatic organisms for aquaculture and ornate at any development stage, to prevent the introduction and dispersion of identifiable and certifiable diseases.	SAGARPA
NOM-017-PESC-1994	Regulates the sport fishing activities on Mexican water bodies.	SAGARPA
PROY-NOM-022-PESC-1994	Establishes the health regulations and their control, as well as the application of HACCP in aquaculture.	SAGARPA
NOM-001-SEMARNAT-1996	Maximum levels of contaminants allowed to discharge in national water bodies	SEMARNAT
NOM-004-SEMARNAT-2002	Contaminants specifications and maximum levels permissible on mud and bio-solids for its usage and discharge	SEMARNAT
NOM-059-SEMARNAT-2001	Native species protection, endanger categories and specifications for their inclusion, exclusion or change within the list of endangered species.	SEMARNAT
NOM-062-SEMARNAT-1994	Biodiversity effects through land usage switch from forestry to agriculture and livestock	SEMARNAT
NOM-113 & 114-SEMARNAT-1998	Environmental impact on the design and construction of electrical stations and lines.	SEMARNAT
NOM-003 & 004-CNA-1996	Prevention of contamination on subterranean waters due to the construction, maintenance and closure of deep wells.	CNA
NOM-005-CNA-1996	Flow meters specifications and tests	CNA
NOM-007-CNA-1996	Water tanks construction and operation	CNA
NOM-188-SSA1-2002	Health specifications of aflatoxins control in cereals for human and animal consumption.	SSA

Appendix 11 Main regulations (NOM) involved in the processing of tilapia products in Mexico (DOF, 2005).

NOM Code	Definition	Institution
NOM-027-SSA1-1993	Health specifications on fresh, chilled and frozen fish products.	SSA
NOM-028-SSA1-1993	Health specifications in preserved fish products.	SSA
NOM-120-SSA1-1994	Food and drinks processing hygienic and healthy practices.	SSA
NOM-128-SSA1-1994	Establishes the application of HACCP on fish products processing plants.	SSA
NOM-129-SSA1-1995	Health specifications and regulations on dried-salted fish products.	SSA
NOM-130-SSA1-1995	Health specifications and requirement on food hermetically packed and thermically treated.	SSA

Appendix 12 Main regulations involved in the trade of tilapia products in Mexico (DOF, 2005).

NOM Code	Definition	Institution
NOM-002-SCFI-1993	Net content verification methods and tolerance in packed products.	SE
NOM-008-SCFI-2002	Mesurement units general system	SE
NOM-030-SCFI-1993	Quantity declaration in label	SE
NOM-051-SCFI-1994	General specifications of food and non-alcoholic drinks labelling packaging.	SE
NOM-016-SSA2-1994	Monitoring, prevention, control, management and treatment for cholera	SS
NOM-086-SSA1-1994	Nutritional specification on the composition modifications in food and non-alcoholic drinks.	SS
NOM-092-SSA1-1994	Method for counting aerobic bacteria in plates.	SS
NOM-093-SSA1-1994	Hygienic and health practices in the preparation of food offered on fixed establishments.	SS
NOM-110-SSA1-1994	Preparation and dilution of food samples for microbiological analysis.	SS
NOM-111-SSA1-1994	Food moulds and yeasts quantifying methods.	SS
NOM-112-SSA1-1994	Determination of coliforms bacteria	SS
NOM-113-SSA1-1994	Methods for counting total coliforms micro-organisms in plates.	SS
NOM-114-SSA1-1994	Method to determine salmonella in food	SS
NOM-115-SSA1-1994	Method to determine Staphylococcus aureus in food	SS
NOM-116-SSA1-1994	Determination of humidity in food through thermic treatment.	SS
NOM-117-SSA1-1994	Method to determine cadmium, arsenic, lead, tin, cupper, iron, zinc and mercury in food, tap water and drinking water through atomic absorcion spectrometry	SS

Appendix 13 Major development programs from CONAPESCA for fishery and aquaculture.

Program	Objective
Value Webs Construction and Fortification Program	To consolidate more competitive fishery and aquaculture production units and articulated in value webs, through the system-produce committees, improving its level of organisation, productivity, generating value-added products and incuse in national and international markets.
"Alianza Contigo"- Aquaculture and Fishery Program	To supply subsidies or resources for the capacitating of the producers, development of the primary construction and trade infrastructure, as well as for the formulation and execution of productive projects that promote and boost the rational and sustainable exploitation of the fishery and aquaculture resources.
National Support Program for Rural Aquaculture	To promote and boost aquaculture, creating family or community production units highly profitable and competitive, contributing to improve the socio-economical conditions of the rural sector in highly deprived zones.
Technological Training and Assistance Program	To link the requirements needed to fortify the technical and administrative capabilities of the production sector, with the primary and complementary strategies of the national fishery and aquaculture policy in relation to a Federal-State coordination.
Aquatic Health National Program (PRONALSA)	To establish the required measures to reduce the risk of introduction and dispersion of pathogens within the national territory, and to maintain the aquaculture sector with minimum health risks

Appendix 14 Promotion and support institutions involved in the development of the tilapia industry in Mexico.

Abbreviation	Official Name	Description	Institution Dependant
ASERCA	Apoyos y Servicios a la Comercializacion Agropecuaria (Support and Services for the trade of Agri-products)	To fortify the trade of agri-products (including livestock and fishery products), administrate the Direct Rural Support Program (PROCAMPO) and promote the employment of trade promotion schemes like quality certification schemes, direct trade (like fair trade) schemes, promotion bureaus schemes and human capability promotion in agri-business schemes.	SAGARPA
PAASFIR	Programa de Apoyo para Acceder al Sistema Financiero Rural (Rural Financing Systems Access Support Program)	Facilitate the access of financing schemes from private and development institutions banks to producers	SAGARPA
SIAP	Servicio de Información y Estadística Agroalimentaria y Pesquera (Agrifood and Fishery Information and Statistic Service)	To provide trustful and appropriate information for decision making in sustainable rural development to agriculture and fishery producers as well as to economical agents involved in the agri-business chain	SAGARPA
SENASICA	Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria (National Service for Agri-food Health, Innocuiness and Quality)	To regulate, supervise, survey and certify the health, innocuiness and quality of agriculture, livestock and aquaculture products in favour of the agri-food chains values.	SAGARPA
FIRA	Fideicomisos Instituidos en Relación con la Agricultura (Trusts Created in Relation to Agriculture)	To grant credits, warranties, training, technical assistance, and technology transfer to the agriculture and fishery sector in the country. Administrates the Fund of Guarantee and Promotion for Fishery Activities (FOPESCA).	BANXICO
SEDESOL	Secretaria de Desarrollo Social (Ministry of Social Development)	To formulate and coordinate the policy for social sharing and subsidiary of the federal government, targeting the general well being of the population	SEDESOL

Appendix 15 Research and Educational Institutions involved in the development of the tilapia industry in Mexico.

Abbreviation	Official Name
INIFAP	Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarios (National Intitute of Forestry, Agriculture and Livestock Research)
CIAD	Centro de Investigacion en Alimentacion y Desarrollo (Food and Development Research Centre)
UNAM	Universidad Nacional Autonoma de Mexico (National Autonomus University of Mexico)
ITMAR	Instituto Tecnologico del Mar (Technological Institute of the Sea)
CINVESTAV	Centro de Investigacion y de Estudios Avanzados del IPN (Research Centre and Advance Studies from the IPN)
CP	Colegio de Postgraduados (Postgraduate College)
CEIEGT	Centro de Ensenanza, Investigacion y Extencion en Ganaderia Tropical (Education, Investigation, and Tropical Livestock Extention Centre)
UAIM	Universidad Autonoma Indigena de Mexico (Native Autonomus University of Mexico)
UJAT	Universidad Juarez Autonoma de Tabasco (Juarez Autonomus University of Tabasco)
ECOSUR	El Colegio de la Frontera Sur (Couth Border College)
EPOMEX	Centro de Ecologia, Pesquerias y Oceanografia del Golfo de Mexico. Universidad Autonoma de Campeche (Ecology, Fisheries and Oceanography of the Golf of Mexico Centre, Autonomus University of Campeche)
CESUES	Centro de Estudios Superiores del Estado de Sonora (High Research Centre of the State of Sonora)
CICESE	Cento de Investigacion Cientifica y de Educacion Superior de Ensenada (Scientific Investigation and High Education Cantre of Ensenada)

Appendix 16 2001–2006 governmental strategy for the promotion of economical and social gains of aquaculture and fisheries in Mexico (SAGARPA, 2001).

Strategy	Activity
To promote the organisation and training of producers.	- Training - Organisation for production. - Technical assistance to producers - ID's for fishermen.
To develop productive chains allowing the producer to keep a larger proportion of the added value.	- Promotion of producers associations to integrate the supply of fishery products - Improvement and enlargement of collection centres, and distribution and marketing channels of fishery and aquaculture products. - Promotion of fishery and aquacultural products consumption
To strengthen the growth and diversification of aquaculture	- Technology transfer and adaptation for aquaculture - Regulation of health in aquaculture - Rural aquaculture promotion - Inter-sectoral coordination to provide inputs of high quality and at competitive prices for the aquaculture sector - Promotion of projects and investment
To up-date the methods for capture	- Rehabilitate and replace of boats - Inter-sectoral coordination to provide inputs of high quality and at competitive prices for the fishery sector
To promote an up-to-date and competitive industry within the sector	- Promotion and consolidation of micro and small businesses - Assist and support the modernization of processing plants
To promote the modernization of the fisheries and aquaculture infrastructure, and rehabilitate the natural conditions of coastal lagoons systems	- Rehabilitation of the coastal lagoons systems - Construction of fishery and aquaculture support infrastructure in rural communities - Promotion of the modernization of the fishing ports infrastructure.
To promote businesses opportunities within the sector	- Fortify the international cooperation in Mexico and participation in international seafood forums - Promotion of economical tools for the promotion of investment (financial, fiscal, commercial, participatory funds)

Appendix 17 Main financing institutions and organisations involved in the development of agri-businesses in Mexico.

Abbreviation	Official Name	Description	Institution Dependant
FOCIR	Fondo de Capitalización e Inversión del Sector Rural (Capitalization Fund for Rural Investment)	To vinculate national or international private and governmental funds to rural projects	NAFINSA
FIRCO	Fideicomiso de Riesgo Compartido (Shared Risk Trust)	To promote and boost competitive agri-businesses in the rural sector, through development programs, facilitating the access to public and private resources to the population together with specialised services.	SAGARPA
FINCA	Fondos de inversión y capitalización (Investment and Capitalisation Fund)	Fund designed as a complementary guarantee to obtain a loan from private banks, FIRA (with discount) or FINRURAL.	SAGARPA
FOPESCA	Fondo de Garantía y Fomento para las Actividades Pesqueras (Fund to Guarantee and Promote	Fund designed to finance fishery activities.	FIRA
FEGA	Fondo Especial de Asistencia Técnica y Garantía de Créditos Agropecuarios (Fund for Technical Asistance and AgriCredit Guarantee)	Fund designed to promote technological assistance and credit guarantee	SAGARPA
FEFA	Fondo Especial Para Financiamientos Agropecuarios (Fund to Finance Agribusinesses)	Fund designed to finance all agribusinesses	SAGARPA
FONDO	Fondo de Garantía y Fomento para la Agricultura, Ganaderia y Avicultura (Fund of Guarantee and Promotion for Agriculture, Livestock and Poultry)	Fund designed to finance agricultural, livestock and poultry businesses.	SAGARPA
FOMAGRO	Fond de Riesgo Compartido para el Fomento de Agronegocios (Fund for Risk shering for the Promotion of Agribusinesses)	Fund designed to share the risk involved in agribusinesses financing	SAGARPA
FONAES	Fondo de apoyo a las Empresas de Solidaridad (Fund for the Support of Solidarity Enterprises)	To promote productive projects and social enterprises that generate jobs and incomes for the population who live in exttreme poverty; specially native, peasants and urban social groups, promoting the improvement of life conditions and rooting on their communities of origin.	SE
BANCOMEXT	Banco Nacional de Comercio Exterior (Foreign Trade National Bank)	To promote and finance operations in the field of trade and foreign investment	SHCP, SE, SAGARPA, SRE, ST
BANRURAL	Banco Nacional de Credito Rural (National Bank of Rural Credit)	To promote and finance operations in the field of agriculture investment. Currently under liquidation, replaced by FINRURAL.	SAE
NAFINSA	Banca de Desarrollo Nacional Financiera SNC (Development Banking Institution)	To promote the overall development and modernization of the industrial sector with a regional approach; stimulate the development of financial markets and act as financial agent of the Federal Government in the negotiation, contracting and management of credits from abroad.	SHCP
FINRURAL	Financiera Rural (Rural Financer)	To promote and finance all activities related to the rural sector, thus grant credits for the development of any agri-businesses in rural areas.	SHCP

Appendix 18 2001–2006 governmental strategies for aquaculture and fisheries legislation development (SAGARPA, 2001).

Objective	Strategy	Project
Sustainable exploitation of the fishery and aquaculture resources	*Establish and operate a process for statistical planification, administration and generation to support the decision making in the fisheries legal framework*	+ Strategically plannification of fisheries + SIRIAP operation + National fisheries registry + Appropriate indicators of the fishery and aquacultural activities + Fishery geogrphical information system + Fishery information + Definition of the base methodology for stadistical estimations + Fishermen welfare survey + Production chains study + Fishery processing plants census + Decentralisation of human, material and financial resources + Modernisation of the administration of human, materials and financing resources
	Establish, with scientific-technical bases, management schemes for fisheries and aquaculture resources	+ Administrative measures for aquaculture and fisheries management + Fisheries and aquaculture management plans + Sites prospection for the development of aquacultural zones + Participation of Mexico in regional organisations
	Promote the participation of the productive, academic and the three levels of government sectors in the definition and evaluation of opportunities for the development of fisheries and aquaculture	+ Establishment and operation of fishery and aquaculture commeettes + Administration funds with the participation of the three levels of government and the productive sector
Confer and favour legal certainity in fishery and aquaculture activities	*Give access and/or exclusivity to the fisheries and aquaculture resources exploitation within the legal framework*	+ Norms for fisheries and aquaculture + Legislation and state aquacultural charts + Modernisation of the process for issuing permts, consecion and authorizations + Certified process ISO-9002 + Issue and following of permits, consecions and authorizations
	Promote the actualisation of the legal framework related to fishery activities	+ Revision of the fishery legal framework and formulation of the concerning propocisions + Legal support to the Commission activities and defence of its interests
	Fortify the inspection and surveillance actions in fishery and aquaculture activities	+ Creation and operation of the General Inspectorate and Survailance Control + Formation of specialised fishery and aquaculture officials + Policies design to secure the fullfilment of the legislation related to fisheries + Spread the fishery and aquaculture legislation and preventive measures + Identification and aplication of hi-tech and systems for the inspection and surveillance
Contribute to the fishery and aquaculture legislation under the principles of sustainability and resposable fishing	*Develop and operate innovative process for planification, that support the decision making in relation to aquaculture and fishery research*	+ Coordination of aquaculture and fishery research + Administration funds with the participation of the three levels of government and the productive sector + Legal support
	Contribute with results of cientific and technological research to guide aquaculture and fisheries resources management schemes	+ Definition of fishery and aquaculture management plans + Research targeted to the development of aquaculture + Research for the development of traditional and coastal fisheries management schemes + Development of efficient and selective fishing systems + Prospection of resources for its commercial exploitation + National Fishery Chart

Appendix 19 Future trends on fisheries and aquaculture regulation (SAGARPA, 2001).

Issue	Strategy
Actualisation of the aquaculture and fisheries legal framework	+ Revising and continuing those policies showing a real impact in the development of the sector, assuring consistency and certainty + Promoting modifications in the legal framework to allow regional management and administration of the resources + Developing a more adequate legal framework providing better security in the use of federal zones
Fisheries and aquaculture legal program	+ Developing more regulations (NOM's) for the promotion of sustainable fisheries, as well as up-dating the existing ones + Making permits, concessions and authorisations for resources usage or exploitation more effective and agile, through issuing permits valid for longer periods, substitute permits for concessions, and establishing a more efficient controlling system + Evaluating and following all permits, concessions and authorisations with the application of more efficient certified administrative processes, i.e. ISO 9002.
Inspection and surveillance	+ Wide broadcasting and advisory program on the actual legal framework + Strengthening the coordination and communication between monitoring and enforcement institutions + Promoting the establishment of coordination policies and agreements between the different levels of governments (Federal, state and municipal) and the producing sector tackling illegal pouching and fishing, promoting security amongst the society.