KLAIPĖDA SCIENCE AND TECHNOLOGY PARK

Supply Chain for geothermal aquaculture

Feasibility study

[Aquaculture is the raising of fish and other aquatic animals in a controlled environment — basically it is the farming of fish, shellfish, and other freshwater or marine (saltwater) creatures. Using geothermal water in aquaculture helps to keep water temperatures consistent, which increases survival rates and makes the creatures grow faster.]

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Content

1. Direct use of geothermal resources for aquaculture applications

Aquaculture is the raising of fish and other aquatic animals in a controlled environment — basically; it is the farming of fish, shellfish, and other freshwater or marine (saltwater) creatures. Using geothermal water in aquaculture helps to keep water temperatures consistent, which increases survival rates and makes the creatures grow faster.

Low-temperature geothermal resources that are not hot enough to produce electricity are very useful to fish farmers. Animals grown in water of the proper temperature grow faster and larger in size than those in cold water or the water with fluctuating temperatures. They are also more disease resistant and die less frequently. Fish farmers with access to geothermal water can use it to regulate the temperatures of their fish ponds.

The scope of geothermal fish farm applications is growing rapidly. There are geothermal eel farms in Slovakia. China has over 200 hectares of geothermal fish farms, while Japanese fish farms grow eels and alligators. There are also fish farms in France, Greece, Israel, Korea, and New Zealand. The main species raised in geothermal waters are catfish, bass, trout, tilapia, sturgeon, giant freshwater prawns, alligators, snails, coral, and tropical fish. The warmth of geothermal water makes it possible to raise tropical marine (saltwater) species in cold, landlocked places such as Lithuania.

Some creatures have a range of temperatures in which they thrive. For example, catfish and shrimp grow at about 50 percent of optimum rate at temperatures between 20 and 26 C and grow fastest at about 90 F (32 C), but they decline at higher temperatures. Trout thrive at around 15.5 C but dislike lower or higher temperatures. All the aquaculture applications are related to thermal energy; geothermal sources make it possible to supply it at very good price and steadily.

Scientists are investigating possibilities to grow plants consumable by humans and animals using geothermal aquaculture. Possible crops include kelp, duckweed, algae, and water hyacinth. The technology still needs research to allow economically advantageous harvesting and processing.

Economic impact

Economically, using geothermal energy to heat water for aquaculture can have many benefits. The water that has already been used for heating or electricity generation can heat fish ponds basically for no cost. The savings on thermal energy according to different sources varies from 75 to 85 %. The effect on general running costs can be from 20-40 %, although as Lithuania is a cheap labor country the effectiveness on running costs can be even higher. There is also an economic benefit from selling the fish or prawns that they produce. The fish grown in geothermally heated water grow faster. Heated water makes it possible to grow fish in winter while usually it is not be possible. Geothermal power makes it possible to supply exotic fish species **fresh** for the EU market.

Environmental impact

A farm that uses geothermal water is not burning fossil fuels or other sources of heat to regulate water temperature and is therefore not emitting pollutants. Many geothermal aquaculture operations use water that has already been used by geothermal power plants or heating systems.

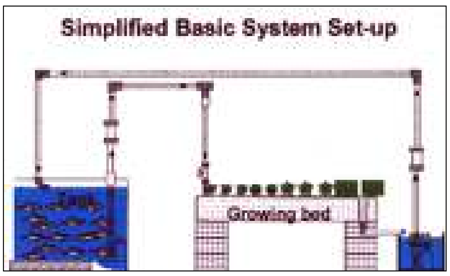
Aquaculture itself takes pressure off wild fisheries, many of which have been severely overfished.

2. Background for geothermal aquaculture application in Vydmantai (Lithuania example).

Aquaculture is one of the fastest growing segments of the world agriculture market and is attracting many into the aquaculture business who have little exposure to the technology. Researchers are developing different new aquaculture technologies (closed recirculating systems, policulture ponds, new water organisms species for aquaculture etc.), or developing the existing technologies using aquaponics systems, thermal waters or both of them. In the USA Aquaculture package is being developed specifically for geothermal aquaculture, which includes pond-heating requirements (indoor and outdoor), information on intensive and extensive culture, information on the culture of common species, current market prices for common species, and typical operating costs for a geothermal aquaculture operation. The future of geothermal direct-use applications is bright: aquaculture and greenhouse operations are continuing to expand. One of the new (in reality – not very new) is an aquaponic system – the basic schemes of which please see below:

Aquaponics: aquaculture + hydroponics

- Basic system components



www.townsqr.com/snsaqua/page2.htm

Picture 1. Simplified Basic System Set-up

The main advantages of such systems are:

- Intensive form of aquaculture.

- Aquaponic systems consume as little as 1% of the water consumed by conventional fish pond systems;

- Fish waste (N and P) is used for plant growth;

- Dual-cropping;

- A little amount of wastewater is released into the environment;

- Hydroponic plants grow faster than those raised by conventional methods;

- „Green production“ for consumers

Geothermal aquaculture, the "farming" of water-dwelling creatures, uses natural warm water to increase the growth of fish, shellfish, reptiles and amphibians. In China, for example, geothermal aquaculture is growing so fast that fish farms cover almost 2 million square meters (500 acres). In Japan, aqua farms grow eels and alligators. In the U.S. aqua farmers in Idaho, Utah, Oregon and California grow catfish, trout, alligators, and tilapia -- as well as tropical fish for pet shops. The geothermal aquaculture is starting in Iceland, Bulgaria, Hungary and other European countries.

Future food supply worldwide appears increasingly dependent on the development of aquaculture, particularly in those countries where the use of animal proteins (meat, eggs, milk and derivates) is limited. While traditional fishing has reached near saturation, aquaculture might have important developments as its production can be planned in advance according to market conditions. Intensive aquaculture is particularly interesting, as it can be developed using hot waters (thermal aquaculture). In fact, a direct relation exists between produced biomass and temperature, each type of biomass having its optimal temperature. Thermal aquaculture may double fish growth with respect to natural waters average values, being moreover independent from seasonal cycles.

Where the chemical treatment of these waters is uneconomic, sufficient amounts of fresh or suitably saline waters could be heated using the polluting geothermal fluids. These fluids will then have to be disposed of an injection well with subsequent cost increases. ***The heating of cold waters with geothermal fluids can be obtained through:***

1) Heat exchangers, placed outside the RAS,

2) Radiators, submerged in the RAS,

3) Submerged pipes.

In case available temperatures are too low, some increase in temperature could be obtained by passive solar systems (greenhouses, tunnels, etc.). If, on the contrary, the temperature of geothermal waters is too high, they will have to be cooled by mixing or heat exchange with sufficient quantities of cold water. In any case the initial temperature of the fluids will have to be by 3-10° C higher than that of the aquaculture farm system, to account for losses due to heat exchange and transportation.

Cultured fish species are being improved for a multitude of features including growth rate, feed conversion efficiency, body shape, dress out percentage and carcass quality. Among the commercial characteristics of carps, flesh quality is becoming more important to the aquaculture industry. The consumer dictates the flesh quality and it is a very complex characteristic.

The growth rate of fish is one of the most important traits for fish farming. A high growth rate increases production turnover and a fast growing fish reaches a higher body weight before the onset of sexual maturation. A medium to high positive correlation between growth rate and feed conversion rate has been recorded. Thus, selection for a high growth rate often results in improved feed conversion. Accurate prediction of the growth potential of a fish stock under given husbandry and culture conditions is an essential prerequisite for any aquaculture production research.

It is very important to consider the tolerance of temperature fluctuations and height temperatures of selected fish species. The best temperatures for the growing technologies is 24 - 28 C^{o} .

At present, there is a long list of fish species cultivated in aquaculture farms. Usually, in temperate or cold climate zone aquaculture is based on pond or RAS systems growing carp, trout, salmon, pikeperch and some other species. Geothermal fluidsis creating a new advantages for the aquaculture in temperate and cold climate zone increasing availability to cultivate new fast growing fish species and other water organisms (as shrimps, for example). The proposed list of species selected according to multiple criteria mentioned above is not finite and could be expanded according to the technology selected.

3.The characteristics of geothermal waters in Western Lithuania

Western Lithuania geothermal field allows using in the region 75-90 ° C from the Cambrian aquifers and 100-145 ° C of the crystalline basement (lying 2.5 -> 4.5 km depth) thermal power generation using the latest version of Kalina cycle technology. Geothermal energy resources in Western Lithuania are quite large. Hydrogeothermical Cambrian complex resources alone are more than 5.1x109 GJ. It is estimated that on average of one pair of wells can produce 5 MW of power to serve 10-20 years. Near the Klaipeda Free Economic Zone and in Rimkai there are 4 boreholes drilled into the Devonian layer (depth 1100 m). Water temperature is +38 ° C in them, the salinity - 95 g / l (chloride - sulfate). In Vydmantai we have 2 wells in the Cambrian layer (depth 2000 m), water temperature 73 ° C and salinity - 170 g / l (chloride).

Picture 2. Location of wells in Klaipeda

Picture 3. Location of wells hols in Vidmantai

Table 1. The main characteristics of geothermal waters in Western Lithuania

		Vidmantai1	Vidmantai1	Vidmantai2	Vidmantai2	Vidmantai2
Analysedby:		GIL	GSD	GIL	GFZ	GFZ
Depth:	m	1987-1997	1987-1997	1951-1960	1961-1962	1972-1973
Temperature:	°C	72.5	73		73.8	74
pH					6.0	5.6
Redoxpotential	mV				-70	-132.8
TDS	g/l	164	170	170	167	167.5
MainCompounds	mg/l					
Sodium: Na^{+}		32597	28200	36442	34670	36000
Potassium: K^{+}		814	910	872	704	722
Calcium: Ca^{2+}		23276	29300	21890	23820	21820
Magnesium: Mg^{2+}		3673	3850	3804	2317	3819
Strontium: Sr^{2+}					430	452
Manganese: Mn^{2+}					2	10
Iron: Fe^{2+}		40	24	51	15	50
Ammonium: NH_4^{+}		8		7,2	6	8.5
Chlorine: Cl^{-}		102295	105700	106380	104000	103000
Sulfate: SO_4^{2-}		313	312	19	125	50
Bicarbonate: HCO_3^{-}		3	48	95	48	32
Bromine: Br^{-}		826	780	803	770	790

4. The list of species for possible aquaculture farms using geothermal waters in Western Lithuania.

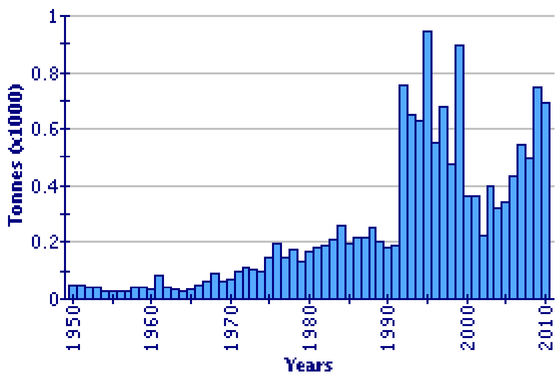
Starkis - Pike-perch (Sanderlucioperca L.)

The beginning of pike-perch culture date to the nineteenth century and pike perch was produced in insignificant quantities as a so-called additional fish in carp ponds. It was produced in monoculture (summer fry) or in polyculture with carp (fall fry). Pond pike-perch culture also began to develop in Western Europe (e.g. France) in the second half of the twentieth century. This type of pike-perch production has been and remains extensive in character, and this species has been and currently is viewed only as a supplementary fish.At the beginning of the twenty-first century, the first aquaculture facilities producing pike-perch in recirculation aquaculture systems (RAS) were established in Western Europe and, by the close of the first decade, there were less than ten of these facilities. Methods for intensive pike-perch culture are in the initial stages of development but this species is considered to offer good prospects for European aquaculture. Currently, the main producing countries are the Czech Republic, Denmark, Hungary, Romania, Tunisia and Ukraine. In addition to the other countries shown on the FAO map, pike-perch are also grown in the Netherlands and Poland.

Picture 4. Main producer countries of Pike-perch (FAO FisheryStatistic, 2009)

For the geothermal waters proposed production system is RAS.According FAO information this is the newest method, and it is used at hatcheries equipped with RAS and cooling systems for reducing water temperatures. Fish are stimulated environmentally (temperature and photoperiod). Thermal stimulation lasts for 18 weeks – 8 weeks cooling phase (20-8 °C), 6 weeks chilling phase (8-4-8 °C), 4 weeks warming phase (8-12 °C). Photoperiod stimulation is used exclusively during the warming phase when it is changed from 8L:16D to 14L:10D.This method is still under development; fewer than ten facilities in Europe are currently using it. Juveniles of 15-30 g are stocked. In the initial stages (BW 15-100 g), when 2-5 m^3 tanks are used, the stock is maintained at 10-30 kg/m^3. Larger tanks (20-30 m^3) are used for the final stage, in which the fish are reared to >1 kg at a maximum stocking density of 80 kg/m^3. The fish are sorted 2 or 3 times, firstly at 100-150 g, secondly at 200-250 g, and thirdly when the fish attain 500-600 g. Fish of >1 kg can be obtained after about 15-18 months of on-growing in RAS.The thermal optimum for pike-perch growth is about 27-28 °C but fast growth rates are already noted at 23 °C. The following contribute to the costs of producing 9-10 g fingerlings in RAS (initially stocked with 0.2-0.5 g summer fry from earthen ponds): labor 40 percent, energy 28 percent, feed 12 percent, fry 20 percent.

The cost of producing 10 g fingerlings in RAS (2009) is ~ USD 0.6/individual. Labor costs are 43 percent of the overall costs, depreciation 12 percent, and feed 7-10 percent. The way to lower costs is to increase the scale of production and to improve culture efficiency, especially survival. The cost of producing marketable pike-perch (final BW 1.5 kg) is estimated to be USD 6.2-7.0/kg.

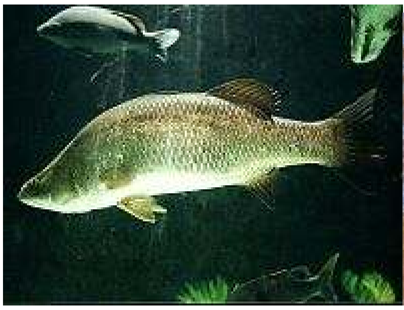


Picture 5. Global aquaculture production of Sander lucioperca (FAO FisheryStatistic)

Artemija - Artemianauplii– for the fish food.

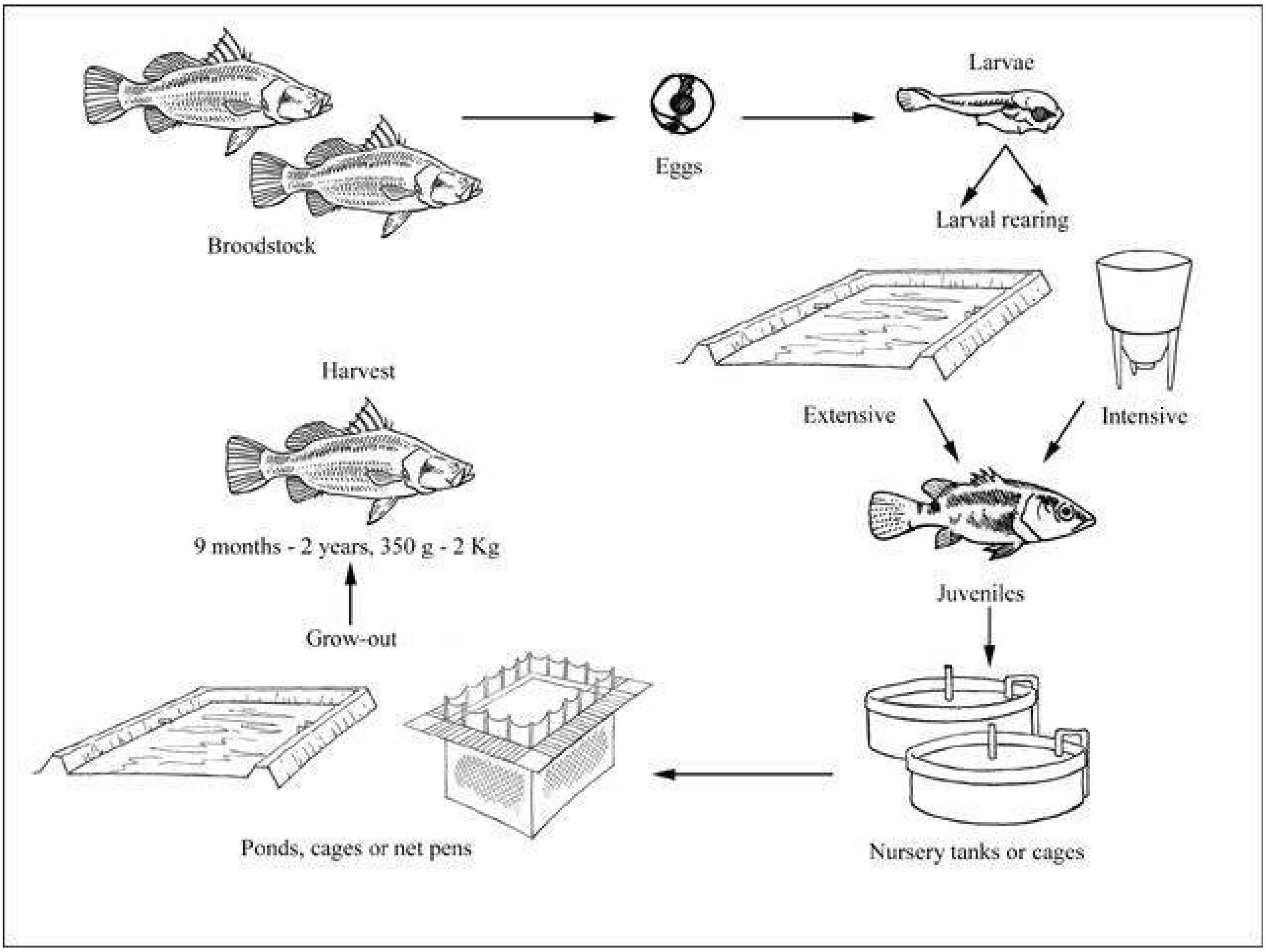
New technology is under development at present and it could be possible to grow this species in geothermal aquaculture farm for fish food as additional aquaculture product.

The barramundi (Latescalcarifer)



Aquaculture of this species started in the 1970s in Thailand, and rapidly spread throughout much of Southeast Asia. Most of the research done in northern Australia has focused on pond culture, however, much of this technology is being transferred to tank culture systems, Tank culture technology has made it possible for most mainland states to produce barramundi. Growing of barramundi in RAS started in Europe from end of last century.

Picture 6. Main producer countries of Latescalcarifer (FAO FisheryStatistics,



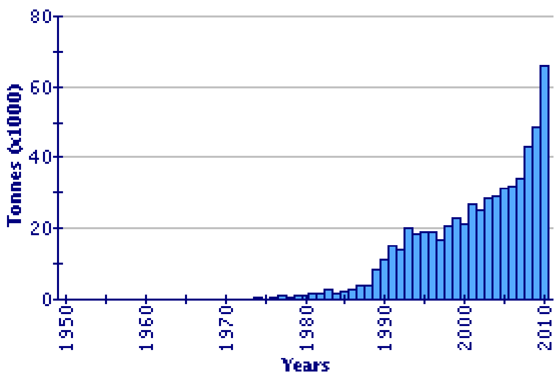
Picture 7. Production cycle of Latescalcarifer

Most barramundi culture is undertaken in net cages. Both floating and fixed cages are used; these range in size from 3×3 m up to 10×10 m, and 2–3 m depth. In Australia and the United States of America, a number of barramundi farms have been established using recirculation freshwater or brackish water systems with a combination of physical and biological filtration. These farms may be located in regions where barramundi could not otherwise be farmed because of consistently low temperatures (southern Australia, north-eastern United States of America). The major advantage of such culture systems is that they can be sited near to markets in these areas, thus reducing transport costs for the finished product.

Stocking rates in tank systems vary, depending on the capacity of the system and the intensity of the operation. Many producers work on a stocking rate of around 30-40kg/m3, however more advanced systems may be able to increase the stocking rate, depending on the experience of the farmer and husbandry practices used.

The optimum temperature for barramundi culture is 28°C, with acceptable growth rates between 26-30°C. Temperatures below this range will result in decreased metabolism and growth. Barramundi generally stop feeding at temperatures below 20°C. To maintain acceptable growing temperature conditions, some existing farms rely on the use of warm subterranean bore water and climate controlled or insulated sheds. Expensive alternatives include the heating of individual tanks with electric submerged heaters. At optimum temperatures, barramundi can be raised to market size (500g) between 6-12 months.

Economic models of barramundi farming in Australia have estimated the break-even cost for a small (50 tonnes/yr) Australian farm to be AUD 9.25/kg (USD 6.90/kg), and the break-even cost for a 200 tonnes/yr farm at AUD 6.90 (USD 5.1). Larger farms (>1 000 tonnes/yr) are able to take advantage of economies of scale and their production costs are likely to be around AUD 6–7/kg (USD 4.50–5.25/kg). In contrast, barramundi farms in Thailand can produce fish for USD 1.90/kg. Economic modeling of Australian barramundi farms indicated that profitability was particularly sensitive to price, with a decrease of AUD 1.00 (USD 0.75) resulting in an 80 percent decrease in equivalent annual return.



Picture 8. Global aquaculture production of Latescalcarifer (FAO Fishery Statistic)

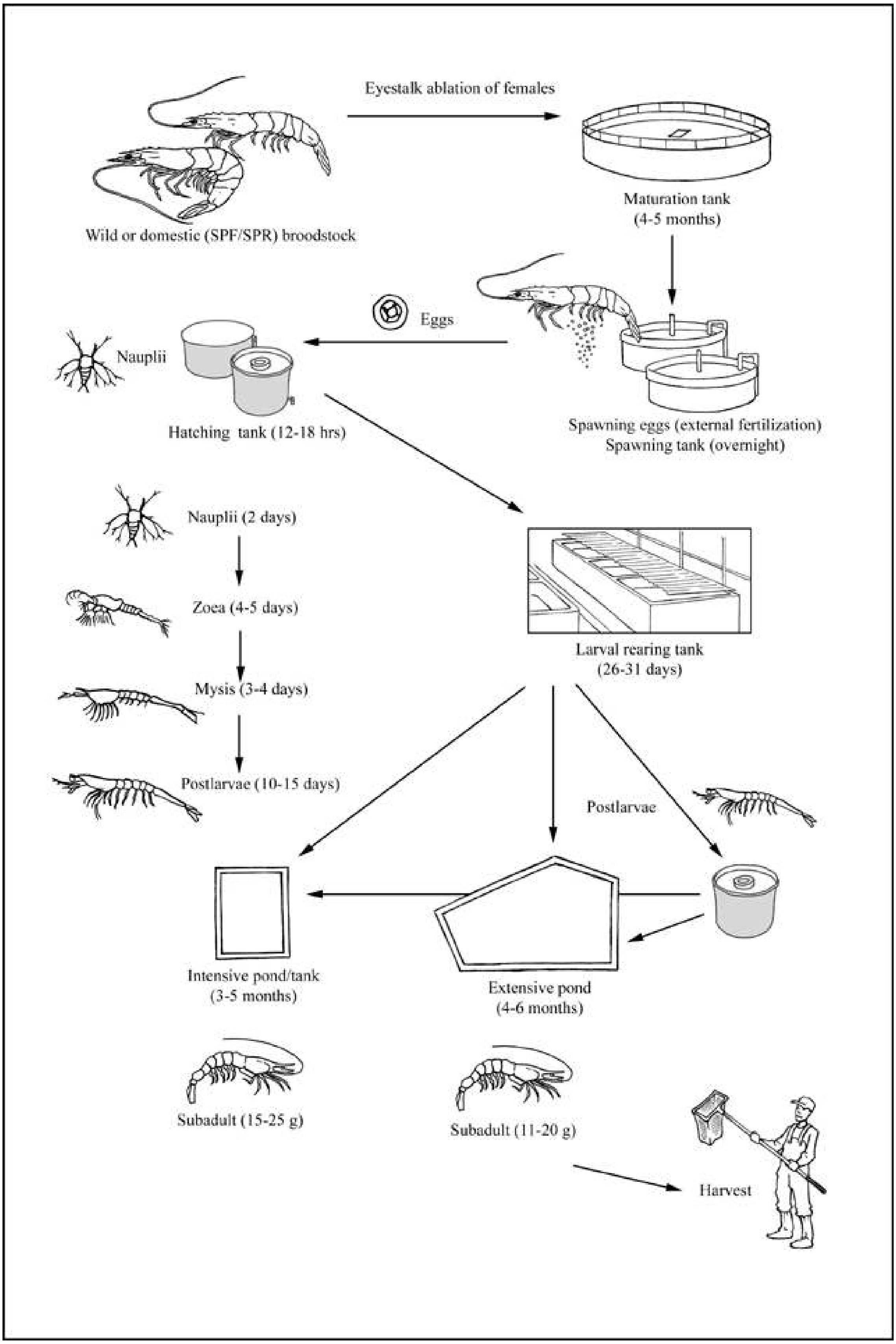
Annual barramundi production has been relatively static since 1998, at ~20 000–27 000 tons. Thailand is the major producer, with about 8 000 tons/yr since 2001. Indonesia, Malaysia and Taiwan Province of China are also major producers. The global average value of farmed barramundi was USD 3.80/kg in 1994 and rose to USD 4.59/kg in 1995 but had fallen to USD 3.92 by 1997. Since then it has been around USD 3.7/kg except for 2002, when it fell markedly to below USD 3.0/kg. Market and trade

Pacific White Shrimp, Penaeusvannamei

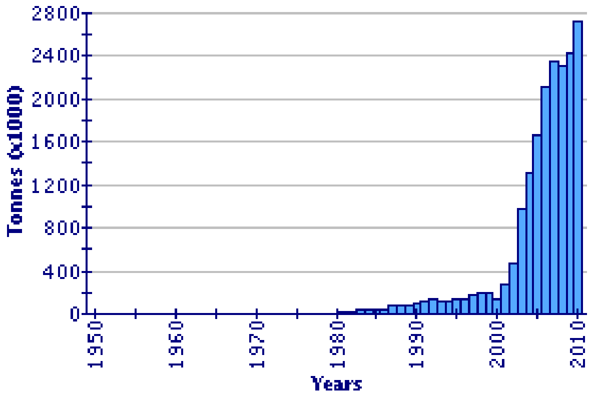
Captured wild seeds were used in Latin America for extensive pond culture of *Penaeusvannamei* until the late 1990s. Domestication and genetic selection programmes then provided more consistent supplies of high quality, disease free and/or resistant PL, which were cultured in hatcheries. Some were shipped to Hawaii in 1989, resulting in the production of SPF and SPR lines, leading to the industry in the United States of America and Asia.

Recent research conducted in the United States of America has focused on growing *P. vannamei* in super-intensive raceway systems enclosed in greenhouses, using no water exchange (only the replacement of evaporation losses) or discharge, stocked with SPF PL. They are thus biosecure, eco-friendly, have a small ecological footprint and can produce cost-efficient, high quality shrimp. Stocking 282 m² raceways with 300–450 0.5–2 g juveniles/m² and on growing for 3–5 months has realized production of 28 000–68 000 kg/ha/crop at growth rates of 1.5 g/week, survivals of 55–91 percent and mean weight of 16–26 g.

The patent-pending technology, known as super-intensive stacked raceways, was created by Dr Addison Lawrence at the Texas AgriLife Research Mariculture Laboratory at Port Aransas, who says the system is able to produce record-setting amounts of shrimp. Sub-licenses are being considered for other countries, including Ecuador, Chile, Colombia, Mexico, Canada, People's Republic of China, Germany, Czech Republic and Russia.



Picture 9. Production cycle of Penaeusvannamei



Picture 10. Global aquaculture production of Penaeusvannamei, (FAO Fishery Statistic)

The major market for shrimp is the United States of America, which was expected to import approximately 477 000 tones worth USD 3.1 billion in 2005, 1.8 times more than the 264 000 tones imported in 2000. The United States of America was traditionally supplied with small frozen or processed headless shrimp from Latin America. More recently, the United States of America has looked to Asia to supply its increasing demand (1.9 kg/capita in 2004). Major suppliers to the United States of America in 2005 were Thailand, Ecuador, India, China and Viet Nam. However, the rapidly increasing production of *P. vannamei*has led to serious price depression in the international markets. Similarly, farm gate value for 15–20 g size whiteleg shrimp has steadily decreased from USD 5/kg in 2000 to about USD 3.0–3.5/kg in 2005.

The next most important market is the European Union (importing 183 000 tones in the first half of 2005), which favours small (31/40 count), whole, frozen shrimp. Japan, whose market mainly requires large headless (16/20 count) shrimp, is typically supplied by *P. monodon* from large extensive Asian farms.

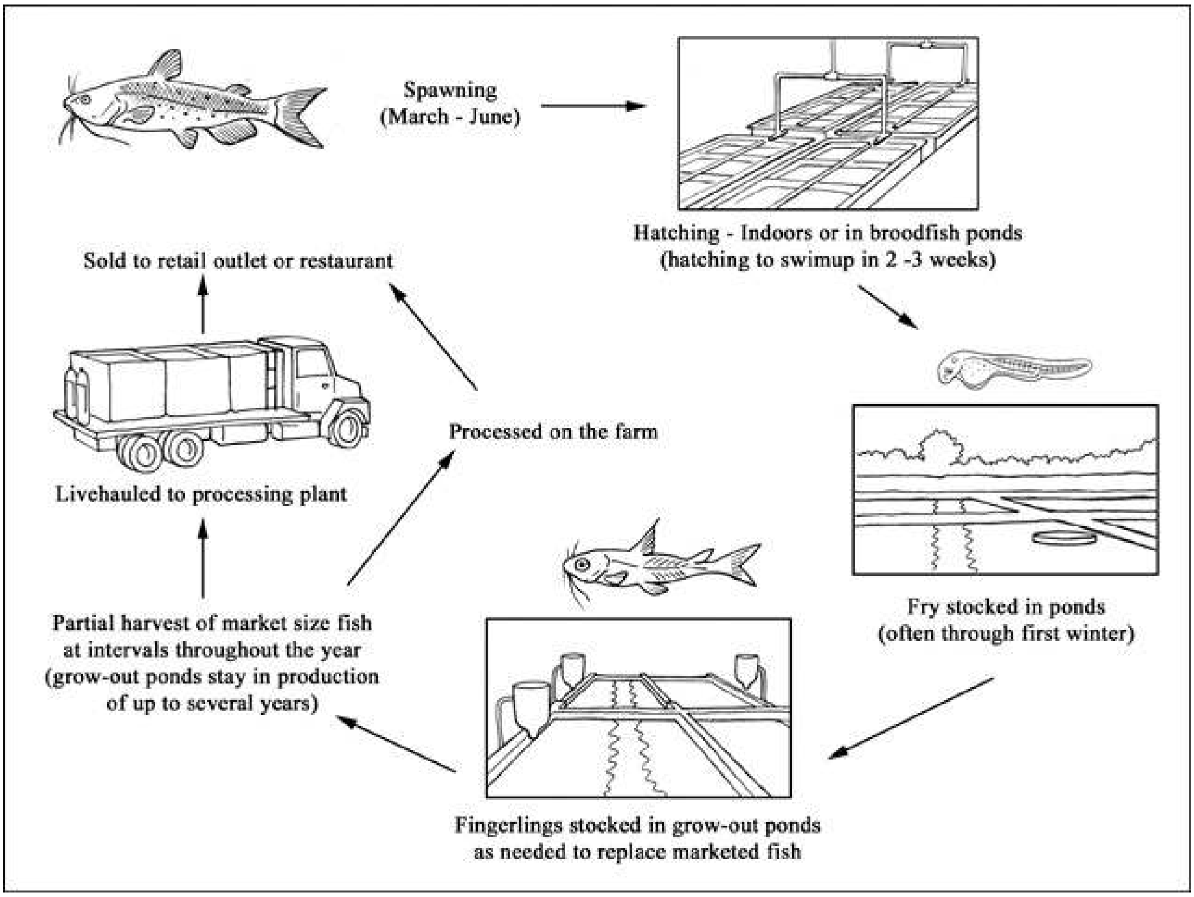
While the expansion of *P. vannamei* culture has been rapid in recent years, particularly in Asia, it has led to reduced value of harvested shrimp. This trend is expected to continue. Under such circumstances, the less efficient producers may not be able to compete with those capable of producing either more eco-friendly or cheaper products. Recent worldwide trends have been towards the integration of the industry, in response to the ever increasing requirement for traceability and control within the culture system.

The channel catfish Ichtaluruspunctatus

Channel catfish are reared in ponds, cages, and circular tanks or linear raceways in both the United States and China. Monoculture dominates in the U.S., while both monoculture and polyculture with traditional species such as carp occurs in China. Formulated feeds are employed in both nations. The details presented below refer to channel catfish culture in the United States of America commercial aquaculture was first considered to be economically practical in the late 1950s. Catfish farming developed rapidly during the 1960s and 1970s as improvements in pond management, disease identification and control, and prepared feeds were developed and adopted by farmers.

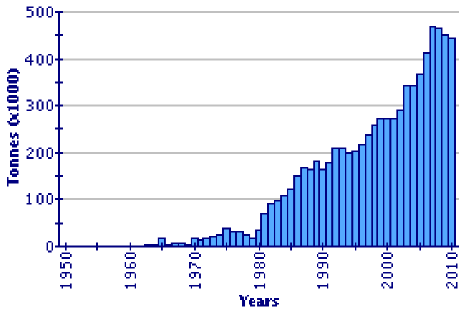
Channel catfish have been introduced into Europe, Russian Federation, Cuba and portions of Latin America. The primary interest in many countries appears to be recreational fishing.

Picture 11. Main producer countries of Ictaluruspunctatus (FAO FisheryStatistics, 2006)



Picture 12. Production cycle of Ictaluruspunctatus

The majority of channel catfish are grown in ponds. Spawning occurs in the spring and may be conducted in open ponds where adults are stocked at a density ranging from 60-325/ha in ratios ranging from 1:1 to 1:4 (male:female) and allowed to select their own mates. Channel catfish are sometimes reared in flow-through tanks or raceways, indoors or outdoors. Recirculating system culture has been attempted over the years but few, if any, economically successful farms have been developed. Flow-through raceway and tank culture depends upon a suitable supply of water of the proper temperature (ideally 26-30 °C) for grow-out. Such water temperatures can be obtained from geothermal waters and from co-generation or electric power generating plants. Production of catfish in such systems represents a small fraction at all. But it should be as one from potential fish species for the geothermal aquaculture farm in western Lithuania



Picture 13. Global aquaculture production of Ictaluruspunctatus (FAO

Channel catfish are reared in ponds, cages, and circular tanks or linear raceways in both the United States and China. Monoculture dominates in the U.S., while both monoculture and polyculture with traditional species such as carp occurs in China. Formulated feeds are employed in both nations.

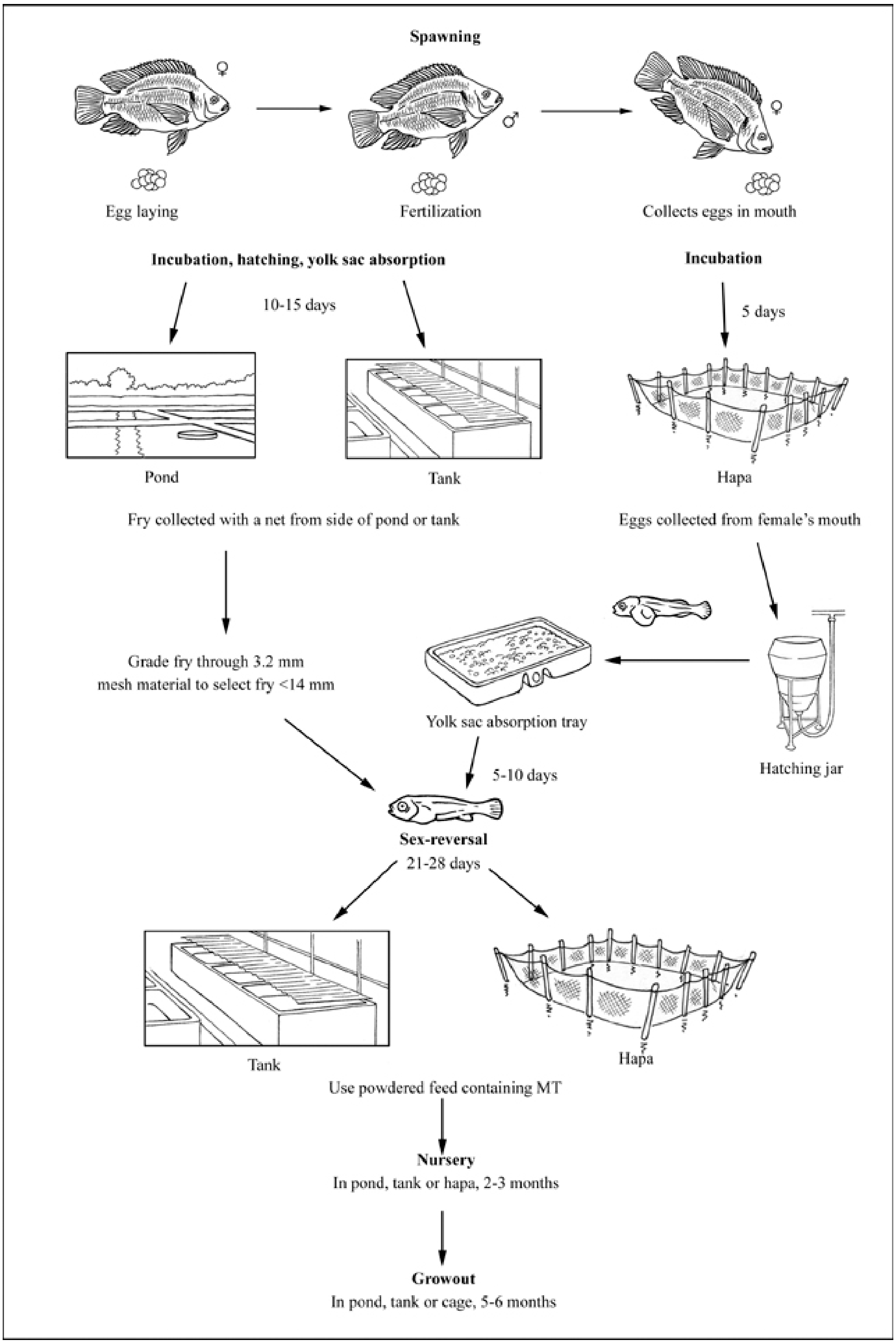
Tiliapija – Tiliapia Oreochromisniloticus Linnaeus, 1758 [Cichlidae]

The culture of Nile tilapia (*Oreochromisniloticus*) can be traced to ancient Egyptian times as depicted on bas-relief from an Egyptian tomb dating back over 4000 years, which showed the fish held in ornamental ponds. While significant worldwide distribution of tilapias, primarily *Oreochromismossambicus*, occurred during the 1940s and 1950s, distribution of the more desirable Nile tilapia occurred during the 1960s up to the 1980s. Nile tilapia from Japan was introduced to Thailand in 1965, and from Thailand they were sent to the Philippines. Nile tilapia from Cote d'Ivoire was introduced to Brazil in 1971, and from Brazil they were sent to the United States in

1974. In 1978, Nile tilapia was introduced to China, which leads the world in tilapia production and consistently produced more than half of the global production in every year from 1992 to 2003.

Picture 14. Main producer countries of Oreochromisniloticus (FAO Fishery Statistics, 2006)

Nile tilapia is a tropical species that prefers to live in shallow water. The lower and upper lethal temperatures for Nile tilapia are 11-12 °C and 42 °C, respectively, while the preferred temperature ranges from 31 to 36 °C.



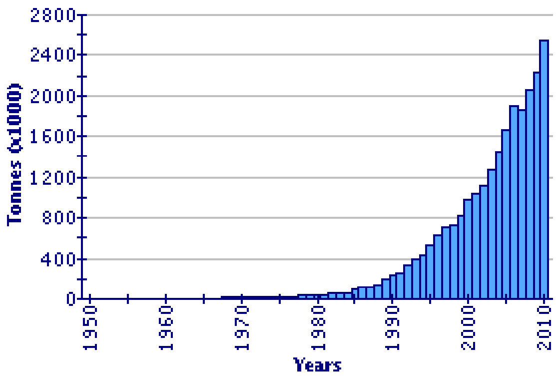
Picture 15. Production cycle of Oreochromisniloticus

Recirculation systems have been developed to culture tilapia year-round under controlled conditions. Although the design elements of recirculation systems vary widely, the main components of recirculation systems consist of fish rearing tanks, a solids removal device, a bio filter, an aerator or oxygen generator and a degassing unit. Some systems apply additional treatment processes such as zonation, denitrification and

foam fractionation. Rearing tanks are generally circular to facilitate solids removal, although octagonal tanks and square tanks with rounded corners provide a suitable alternative with better space utilization.
Production levels in recirculation systems range from 60 to 120 kg/m^3 of rearing tank volume, or more.

Production costs

Tilapia is produced most economically in tropical and subtropical countries, which have favorable temperatures for growth. These countries achieve production costs as low as USD 0.55-0.65/kg, which facilitate trade with the leading importer, the USA. A live weight equivalent of 227 300 tons of tilapia was exported to the USA in 2004. Imported products consist of whole frozen fish, frozen fillets and fresh fillets. Production costs in temperate countries are too high to compete in these markets. Therefore tilapia produced in temperate countries is generally sold in the live fish market, where higher prices can be obtained.



Picture 16. Global aquaculture production of Oreochromisniloticus, (FAO Fishery Statistic)

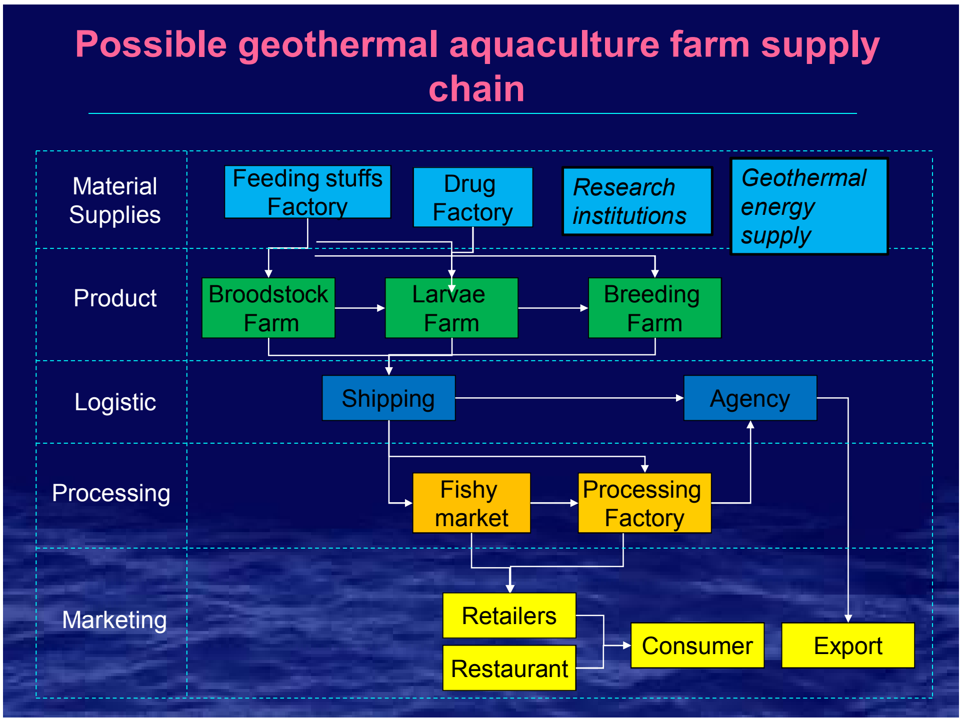
China is by far the largest producer of farmed Nile tilapia. By 2003 annual Chinese production had risen to nearly 806 000 tones and Egypt reported a production of nearly 200 000 tonnes in that year, while the Philippines, Thailand and Indonesia produced 111 000 tones, 97 000 tones and 72 000 tones respectively. The other five 'top ten' Nile tilapia producers were the Lao People's Democratic Republic, Costa Rica, Ecuador, Colombia and Honduras. Brazil and Taiwan Province of China are also major producers of Nile tilapia and many others, such as Cuba, Israel, Malaysia, the USA, Viet Nam and Zimbabwe produce significant quantities annually.

The information is prepared according to:

http://www.fao.org/fishery/culturedspecies/search/en

http://www.hesy.com

5. The geothermal aquaculture farm supply chain



Picture 17. The geaothermal aquaculture farm supply chain

Table 2. Partners required

Technology suppliers	Fish farm equipment for recirculating systems suppliers(RAS). It is necessary to take into consideration that fact that geothermal water will be used by the following heat exchange technics: o Heat exchangers, placed outside the RAS, o Radiators, submerged in the RAS, o Submerged pipes
Feed and drug suppliers	Any of the suppliers that are supplying feed drugs in accordance with aquaculture species list (page8).
Research/ Consultancy	Research institutions that are implementing research in the following fields: 1. Fish genetics and selection;

	2. Fish parasites an deceases; 3. Fish feeding systems; 4. Simulation of the environmental conditions for fish farming; 5. Geothermal energy applications, geology.
Processing and consumers	Producers of fish based food products. Users of raw product (restaurants, fish markets, fish auctions). Marketing consultancy.