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The experience of offshore fish farming in France

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SUMMARY – A natural endowment of three coastlines with different structures, of numerous rivers coming from mountainous regions and of different climatic conditions has enabled France to develop one of the first European aquaculture sectors in terms of volume with almost 300,000 tonnes in 1996. This development has been based on a wide range of species and techniques. Intensive marine fish farming has only been developing during the last decade, after many years of stagnation due to the lack of reliable technology for species suitable for the French climate. Techniques of production are very diverse. Although earth ponds and raceways are used by only 25% of the marine fish farms, this accounts for 40% of the production. By contrast, there are many farms using floating cages in semi-offshore conditions for seabass and seabream, most of which are small scale units These farms use different types of cages. The most popular are rafts made of flexible preformed units or circular flexible cages. French aquaculture has given up projects involving heavy and costly offshore infrastructures inspired from the oil industry or resulting from the reconversion of cargo vessels, but has not yet taken up all the possibilities given by the experience gained in offshore salmon farming.

Key words: Aquaculture, Mediterranean, offshore, cages, technology.

RESUME – *"L'expérience de l'aquaculture en mer ouverte en France". Grâce à la présence de trois façades littorales variées, de nombreuses rivières et de climats différents, la France a pu développer un des secteurs aquacoles les plus puissants d'Europe en terme de volume avec une production approchant les 300 000 tonnes en 1996. Ce développement s'est basé sur une large gamme d'espèces et de techniques. La pisciculture marine intensive ne s'est développée que récemment au cours de la dernière décade, après de nombreuses années de stagnation à cause du manque de technologie pour les espèces adaptées aux conditions climatiques françaises. Ces techniques d'élevage sont très diversifiées. Bien que les bassins de terre et les race-ways ne soient utilisés que par 25% des entreprises, cette technique fournit 40% de la production. Au contraire, beaucoup de fermes utilisant des cages flottantes sont implantées dans des conditions semi-offshore pour l'élevage du bar et de la daurade. La plupart de ces entreprises sont de petite taille. Différents types de cages sont utilisés par ces entreprises. Les systèmes les plus répandus sont les radeaux flexibles formés de modules en matière plastique articulés ou les cages circulaires flexibles. L'aquaculture française a abandonné les projets impliquant des structures lourdes et coûteuses inspirées de l'industrie parapétrolière ou visant à reconvertir des cargos, mais n'a pas encore valorisé pleinement les possibilités offertes par l'expérience acquise par la salmoniculture offshore.*

Mots-clés : *Aquaculture, Méditerranée, offshore, cages, technologie.*

The present status of French aquaculture

General situation

A natural endowment of three coast lines with different structures (flat and sandy, rocky and denticulate), numerous rivers coming from mountainous regions and different climatic conditions (Oceanic, mild continental and Mediterranean) has enabled France to develop one of the most important European aquaculture sectors in terms of volume, with almost 300,000 tonnes in 1996. This development has been based on a wide range of species and techniques.

While landings from fisheries have increased by 14% in volume between 1985 and 1996, aquaculture has grown by 40% in volume over the same time. However, the importance of aquaculture in total French aquatic production for human consumption has not yet exceeded 30% in volume, the

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importance in value has increased from 23% in 1985 to 35% in 1995. In real price terms, the total value of the aquaculture production has increased by 40% while the value of the fisheries landings has decreased by 20% between 1985 and 1995.

Bivalve farming remains the most important activity and accounts for 75% of total volume and 60% of total value of the French aquaculture. The second "traditional" activity is extensive fresh water farming in ponds, mainly for carp. It remains marginal and is especially dedicated to operations of stock enhancement. By contrast, intensive farming of salmonids in fresh water has grown markedly from the sixties onwards, thanks to technological improvements in artificial food and in oxygenation devices.

Marine fish farming

Intensive marine fish farming has only started to grow more recently, after many years of stagnation due to the lack of reliable technology for species suitable for the French climate (Table 1).

Table 1. Marine fish farming production in France (tonnes). Sources: IFREMER, FIOM, Ministère de l'Agriculture, FFA

Species	1990	1991	1992	1993	1994	1995	1996
Seabass (*Dicentrarchus labrax*)	300	650	1000	2000	2193	2689	2272
Seabream (*Sparus aurata*)	75	100	300	342	1158	948	1034
Turbot (*Scophtalmus maximus*)	35	100	150	440	630	694	812
Rainbow trout (*Onchorynchus mykiss*)	800	710	630	501	454	424	375
Fario trout (*Salmo trutta*)	50	70	100	177	890	917	1018
Salmon (*Salmo salar*)	150	200	220	240	456	494	400
Other species of marine fish						29	20
Total marine fish	1410	1830	2400	3700	5781	6195	5931

Seabass and seabream farming

Seabass (*Dicentrachus labrax*) and seabream (*Sparus aurata*) are reared in floating cages, in earth ponds or in raceways. Cages are used in lagoons, sheltered bays or semi-offshore conditions in Corsica and on the French Riviera while ponds and raceways are found on the sandy Mediterranean coast along the Golfe du Lion and near Belgium where an industrial farm uses hot water from a nuclear electricity plant. Some semi-intensive units in earth ponds used to operate on the Atlantic coast but have been unprofitable (La Pomélie, 1995).

Other species

Because of high summer mortalities, the farming of Rainbow trout (*Onchorynkus mykiss*) in floating cages in Brittany is receding. After a promising start, the future of Fario trout (*Salmo trutta*) farming in cages is at stake since the biggest enterprise involved in this species has been bought out by a Norwegian company, which is planning to substitute these with Atlantic salmon (*Salmo salar*). However, the attempt to rear Atlantic salmon offshore on a ship-based system has not fulfilled expectations and the company concerned has become bankrupt because of structurally high production costs. As far as temperature is concerned, turbot *(Scophtalmus maximus)* is one of the best species to be reared on French coasts. However, investments in raceways have proved to be high and few entrepreneurs have followed the pioneer company on Noirmoutier Island, while cage farming does not satisfy the only farm which uses this technique. In the Mediterranean, some farms produce also small quantities of charax (*Puntazzo puntazzo*), meagre (*Argyrosomus regius*) and corb (*Umbrina cirrosa*).

Marine fish farming enterprises and techniques

Concentration of the sector

In France (overseas territories excluded), 47 marine fish farms were operating in 1996, mainly for seabass and seabream. Only two or three new farms have been started up during the last three or four years. At a smaller scale, the concentration of the marine sector is very similar to the concentration of the fresh water trout industry, with many small family farms of under 50 tonnes (mainly seabass), some semi-industrial farms between 50 and 200 tonnes and a few big farms over 200 tonnes. (Table 2). Among the largest farms, only two are above 500 tonnes per year. One of these uses raceways for bass and bream and the other, which was using floating cages for Fario trout in the sheltered extension of Cherbourg harbour, has now shifted to Atlantic salmon with an expected production of 3000 tonnes in 1999.

Table 2. Distribution of French marine fish farms per size class in years 1990 and 1996

Species group	Number of enterprises per size class							
	0-50 t		50-200 t		Over 200 t		Total	
	1991	1996	1991	1996	1991	1996	1991	1996
Seabass and seabream	29	21	2	8	4		31	33
Turbot			1	3	2		1	5
Marine salmonids	7	4	2	1	4		9	9
Total for all species	36	25	5	12	10		41	47
Number of enterprises (%)	88	53	12	26	21		100	100
	Production per size class (tonnes)							
	0-50 t		50-200 t		Over 200 t		Total	
	1991	1996	1991	1996	1991	1996	1991	1996
All species	1220	560	610	1204	4167		1830	5931
Total production (%)	67	9	33	20	70		100	100

Given the small number of farms involved, each of the large farms is located in its own embayment or coastal site, and only the smaller units are gathered together, in sites such as Toulon harbour on the Mediterranean coast. The trend has been for a slight increase in size of the average production site, due as much to development of very big farms as to expansion of middle size farms.

Regional distribution

Two thirds of the French marine fish farm production comes from the oceanic coast, especially for salmonids and turbot. By contrast, for seabass and seabream, 66% of production is realized along the Mediterranean coast, one third in the island of Corsica and two thirds along the mainland shore (Table 3).

Techniques of production

Techniques of production are very diverse. Although earth ponds and raceways are used only by 25% of the marine fish farms, this accounts for 40% of the production (Table 4). This technique has accounted for the largest development in term of quantity over the last six years, thanks to the construction of industrial units. Many other farms have been implemented in semi-offshore conditions using floating cages for seabass and seabream, but most of these enterprises are small in scale, and this technique does not provide more than 16% of the total production.

Table 3. Regional distribution of marine fish farms (1996)

Region	Number of units	Total no. of units (%)	Production (tonnes)	Total production (%)
Northern coast and Normandy	2	4	1800	30
Brittany and Atlantic coast	14	30	2257	38
Western Mediterranean coast	5	11	256	4
Eastern Mediterranean coast	17	36	888	15
Corsica	9	19	730	12

Table 4. Techniques of production in French marine fish farming in years 1991 and 1996

Production system	Number of units		Total no. of units (%)		Production (tonnes)		Total production (%)	
	1991	1996	1991	1996	1991	1996	1991	1996
Raceways	4	8	10	17	339	2207	19	37
Earth ponds	4	2	10	4	28	31	2	1
Concrete and earth ponds	2	2	5	4	19	44	1	1
Cages under tables in lagoon	4	4	10	9	52	230	3	4
Floating cages in lagoon	6	7	15	15	139	427	8	7
Floating cages in river	5	5	13	11	313	554	17	9
Floating cages in sheltered bay	5	5	13	11	50	1066	27	18
Floating cages in semi offshore conditions	8	13	21	28	240	972	13	16
Anchored ship in offshore conditions	1	1	3	2	200	400	11	7

Seabass and seabream farming in semi-offshore conditions

These farms have been establishing since 1988 along the French eastern Mediterranean coast (coastal zone of Provence between Marseille and Nice) and around Corsica. Most are still in the process of expanding, and some purchases and mergers have recently occurred (La Pomélie, 1995). Their average annual production is presently around 75 tonnes with a very little size range, the median being 65 tonnes.

Type of cage

These farms (Table 5) use different types of cages. The most popular are square shaped rafts made of flexible preformed units (Fig. 1) or circular flexible cages (Fig. 2). Submersible cages have been tested by two farms, Aquavar and Aquaviva, but have turned out to be very disappointing. Consequently, they have been abandoned and are now used by only Aquavar, and just for a small part of its production. There is also diversity in cage volume, with three categories: (i) <150 m^3; (ii) 150 m^3 to 500 m^3; and (iii) >500 m^3. While the wooden cages used in sheltered areas are usually home-made or purchased from local manufacturers, cages for semi-offshore conditions come from specialized companies, either Jet-Float (flexible preformed units) or Corelsa (circular flexible cages). Jet-Float cages (100 to 600 m^3) are imported from Austria and Corelsa cages (500 to 1800 m^3) from Spain.

Table 5. Type of cage for seabass and seabream farming in semi-offshore conditions†

Name of enterprise	Type of cage	Unit cage volume		
		<150 m^3	150-500	>500 m^3
A Dorada	Wooden framed cages linked in a raft	x		
Acqua Viva	Flexible circular cages			x
Aquamed	Jet-Float cages	x	x	
Aquavar	Flexible circular cages and submersible cages	x		x
Cannes Aquaculture	Jet-Float cages	x	x	
Campomoro	Wooden framed cages linked in a raft	x	x	
Santa Manza	Wooden framed cages linked in a raft	x		
Spano	Flexible circular cages			x
Cap d'Antibes	Jet-Float cages		x	
Pinarello	Wooden framed cages linked in a raft and flexible circular cages	x		x
Lou Loubas	Jet-Float cages	x		
Provence Aquaculture	Wooden framed cages linked in a raft and flexible circular cages	x		x
Theoule Aquaculture	Jet-Float cages	x	x	

†Evolution expected towards flexible circular cages more than 500 m^3 each.

Fig. 1. Cages made with Jet-Float units (Aquamed farm) – © IFREMER/O. Barbaroux.

Fig. 2. Flexible circular cages (Acqua Viva farm) – © IFREMER/O. Barbaroux.

Types of boat and of feeding system

Different types of boats are used, with or without a crane. Feeding is mostly still manual, but automation has appeared in the largest farms (Table 6).

Table 6. Location, type of boat and feeding system

Name of enterprise	Location	Type of boat			Feeding system
		Small,<6 m no crane	Flat, without crane	Flat, with crane	
A Dorada†	Corsica	xx			Manual
Acqua Viva	Corsica	x		x	Manual
Aquamed	Provence	x		x	Manual
Aquavar	Provence	x		x	Automatic
Cannes Aquaculture	Provence	xx			Automatic
Campomoro	Corsica	xx			Manual/automatic
Santa Manza	Corsica	x			Manual
Spano	Corsica			x	Manual
Cap d'Antibes	Provence	x			Manual
Pinarello	Corsica		x		Manual
Lou Loubas	Provence		x		Manual
Provence Aquaculture	Provence	x			Manual/automatic
Theoule Aquaculture	Provence	x		x	Automatic

†Evolution expected towards automatic feeding system and flat boat with crane.

Regulations for the establishment and operation of marine farms

Marine fish farms in France are submitted to several regulations concerning the use of the water, the use of space and the impact on the environment.

Concerning environmental impact, an application file has to be presented at the local representative of the national administration, to be communicated to the local authority in charge of environment and to the local authority in charge of water and fisheries resources management. The file must content precise information about: (i) the use of the water and the free access to wild fish; (ii) the devices preventing wild fish from going into the farm and farmed fish from escaping; (iii) the general conditions of production in the farm; and (iv) an assessment of the effluents and of the devices in order to control them (only for salmonid farms over 10 tonnes per year and for other fish farms over 20 tonnes).

As soon as the file is considered as correct from an administrative standpoint, it is presented to public enquiry for a period of one month. An authorization is then given and the farmer is committed to respect the quantity of water taken from the river, free circulation of wild fish, norms concerning effluents and measures for self-control. Among the difficulties in implementing these procedures, the major one is the evaluation of environmental impact, as methods to measure effluents and assess their dispersion and effects in water are subject to scientific controversy. The main parameters considered for calculating the norms are suspended solids, nitrogen and phosphorus emission. The pro-environment associations often contest the interpretation of the data.

The law about the use of the coastline is also of concern for marine aquaculture development. This law is aimed at defining a special policy for the coastline in order to reconcile development and conservation. However, although its text makes reference to the development of economic activities such as aquaculture, it is very often interpreted as having a more protective meaning. As the marine area is solely owned by the State, marine farms have to obtain a lease from the State, pending an enquiry conducted by the local Direction of Marine Affairs. The occupation of this public marine area is under strict regulation, describing the conditions for access to a lease. In particular, the intending farmer has to prove either experience in the field or having attended a specific training programme. These leases are not free and a very complicated system of tax calculation has been enacted. This calculation is well adjusted to traditional oyster and mussel farming, or to fish farming in floating cages, but turns out to be very expensive for fish culture on coastal land. The maximum duration of the lease is 35 years.

Constraints, problems and development requirements for offshore mariculture in France

The major constraint in France is the access to space along the coastal margin. Though there are convenient sites for fish farming in offshore and semi-offshore conditions, they are submitted to severe use conflicts. Urbanization, tourism, Navy, wildlife parks projects, harbours, boat traffic are all potential competitors, and are all the more serious as they have been there before aquaculture. Islands are usually less subject to constraints with respect to urban expansion, industry development or intensive agriculture. However, while in Corsica, many sites are easily available, they are often remote, far from any harbours and with difficult road access.

Thanks to the offshore cage technology developed in northern European countries, it is possible to target sites further from the coast. In this case, large volume cages are required, as in the salmon industry. However, these cages are not easy to handle with small fish, and the trend is to do a pregrowing phase in inland or inshore systems, moving stock offshore at 50 to 100 g. The ongrowing phase is the less than one year at sea, reducing risks and labour costs. For this reason, and to improve continuity of supply using temperature and light control, research and development is under way on intensive pregrowing in raceways, using water recirculation. These two techniques, intensive recycle raceways inland, and offshore cages, appear to have potential for further development of fish farming in France.

Conclusions

After a good start, at the same pace as Italy and Spain, the development of marine fish farming in France has been slowing down for several years, due to a lack of new projects (Paquotte and Harache, 1996; Paquotte *et al.,* 1996). In the same time, Italian and Spanish production have been increasing thanks to the implementation of offshore farms (Sicily, the Balearic Islands, the Canaries, Madeira), technical constraints have been removed due to the transfer of northern European offshore technologies to Mediterranean conditions (Stephanis, 1995). In small islands like Cyprus or Malta and along highly urbanized shorelines (Catalonia) where space is a scarce resource, offshore fish farming has proved to be the major way to develop aquaculture (Paquotte and Lacroix, 1997). It makes it possible to avoid direct use conflicts with coastal tourism, which is a major activity around the Mediterranean.

French aquaculture has given up projects involving heavy and costly offshore infrastructures inspired from the oil industry or resulting from the reconversion of cargo vessels but has not yet taken advantage of all the possibilities given by the new offshore technologies used by the salmon industry. Saetremyr, the Norwegian company which has bought out Salmona's plant in Cherbourg harbour, may take this trend forward with a salmon farm project in offshore from Marseille.

Scrutiny from the administration, controversial regulatory constraints and user conflicts concerning the use of the coastal waters are still major problems in France (Bailly and Paquotte, 1996), as well as the lack of entrepreneurs. Although the demand for fresh fish is expanding on the French market, French enterprises suffer tough competition from producers located in other European Mediterranean countries. High labour cost is a constraint for French producers, which makes them look for new techniques with high labour productivity and good control of the environment. That is the reason why, in parallel with the development of semi-offshore farms using flexible circular cages, inland plants with water recirculation systems are still a valuable challenge for research and development. These two techniques may be complimentary in the aim of providing pregrown juveniles in recirculation systems for a shorter cycle in offshore cages.

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