

## THE EXPERIENCE OF OFFSHORE MARINE FISH FARMING IN FRANCE

Proceedings of TECAM seminar « Mediterranean Offshore mariculture »  
IAM Zaragoza 20-24 October 1997

To be printed in *Cahiers Options Méditerranée* - 1998

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**SUMMARY** - A natural endowment of three coast lines 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 on a wide range of techniques. Intensive marine fish farming has been developing during the last decade only, after many years of stagnation due to the lack of reliable technology for species adapted to French climate. Techniques of production are very diverse. Although earth ponds and race-ways are used only by 25% of the marine fish farms, this technique accounts for 40% of the production. On the contrary, many farms using floating cages are implemented in semi-offshore conditions for seabass and seabream. Most of these enterprises are small scale farms. Different types of cages are used by these farms. The most popular systems 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 cargoes, but has not yet valorised all the possibilities given by the new offshore technologies experienced by the salmon industry.

**Key words:** aquaculture, Méditerranéan, offshore, cages, technology

**RESUME** - 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 décennie, 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 or rocky and denticulate), of numerous rivers coming from mountainous regions and of different climatic conditions (Oceanic, mild continental and Mediterranean) 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 on a wide range of techniques.

While the landings from fisheries have been up by 14% in volume between 1985 and 1996, aquaculture has been increasing by 40% in volume during the same time. Nevertheless, the importance of aquaculture in the total French aquatic production for human consumption is not yet beyond 30% in volume. On the contrary, the importance in value has increased from 23% in 1985 to 35% in 1995. In constant French Francs, 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.

Bivalves farming remains the first activity and accounts for 75% of the total volume and 60% of the total value of the French aquaculture. The second "traditional" activity is extensive fresh water farming in ponds, mainly carps. It remains marginal and especially dedicated to operations of stock enhancement. On the contrary, intensive farming of salmonids in fresh water has been increasing a lot from the sixties on, thanks to technological improvements in artificial food and in oxygenation devices.

### Marine fish farming

Intensive marine fish farming has been increasing later, after many years of stagnation due to the lack of reliable technology for species adapted to French climate (Table 1).

Table 1. Marine fish farming production in France (tonnes)

	1990	1991	1992	1993	1994	1995	1996
Seabass ( <i>Dicentrarchus labrax</i> )	300	650	1 000	2 000	2 193	2 689	2 272
Seabream ( <i>Sparus aurata</i> )	75	100	300	342	1 158	948	1 034
Turbot ( <i>Scophthalmus maximus</i> )	35	100	150	440	630	694	812
Rainbow trout ( <i>Onchorynchus mykiss</i> )	800	710	630	501	454	424	375
Fario Trout ( <i>Salmo trutta</i> )	50	70	100	177	890	917	1 018
Salmon ( <i>Salmo salar</i> )	150	200	220	240	456	494	400
Other species of marine fish						29	20
Total marine fish	1 410	1 830	2 400	3 700	5 781	6 195	5 931

Sources : IFREMER, FIOM, Ministère de l'Agriculture, FFA

### Seabass and seabream farming

Sea-bass (*Dicentrarchus labrax*) and sea-bream (*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 Golfe du Lion and near Belgium where an industrial farm uses hot water from a nuclear electricity plant. Some semi-intensive productions in earth ponds used to operate on the Atlantic coast but have turned out not to be profitable (La Pomélie, 1995).

### Other species

Because of high summer mortalities, Rainbow trout (*Onchorynchus mykiss*) farming in floating cages in Brittany is receding. After a promising start up, 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 Atlantic salmon (*Salmo salar*) to Fario trout. On the contrary, the attempt to rear Atlantic salmon off-shore on a boat has not fulfilled the

expectations and has bankrupted because of structural high production costs. As far as temperature is concerned, turbot (*Scophthalmus maximus*) is one of the best species to be reared on the French coasts, but investments in raceways have proved to be high and few entrepreneurs have followed a 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 starting up for 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 familial farms 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 is using raceways for bass and bream and the other one which was using floating cages in the sheltered extension of Cherbourg harbour for Fario trout has now shifted to Atlantic salmon with an expected production of 3 000 tonnes in 1999.

Table 2. Distribution of French marine fish farms per size class in years 1991 and 1996

	No. of enterprises per size class							
	0 - 50 t		50 t - 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
% of the number of enterprises	88%	53%	12%	26%		21%	100%	100%

  

	Production per size class (tonnes)							
	0 - 50 t		50 t - 200 t		over 200 t		Total	
	1991	1996	1991	1996	1991	1996	1991	1996
All species	1220	560	610	1 204		4 167	1830	5 931
% of the total production	67%	9%	33%	20%		70%	100%	100%

Given the little number of farms involved, each of the big ones is located in its own embayment or coastal site, and only the small ones are gathered in some sites like in Toulon harbour on the Mediterranean coast. The evolution is a slight increase in size of the average production site, as well due to the development of the very big farms as to the expansion of the middle size farms.

### Regional distribution

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

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

	number	% total	production	% total
	of units	number of units	(tonnes)	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%

### Techniques of production

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

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

	number		% total		production		% total	
	of units		number of units		(tonnes)		production	
	1991	1996	1991	1996	1991	1996	1991	1996
Race-ways	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	1 066	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 settling since 1988 along the French eastern Mediterranean coast (coastal zone of Provence between Marseille and Nice) and around Corsica. Most of them are still in the process of expanding, and some purchases and merges have recently occurred (La Pomélie, 1995). Their average annual production is presently around 75 tonnes with a very little dispersion since the median is 65 tonnes.

#### Type of cage

Different types of cages are used by these farms (Table 5). The most popular systems are square shaped rafts made of flexible preformed units or circular flexible cages. 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 still used by Aquavar only for a small part of its production. Inside each type of cage, there is also a diversity in volume with three categories (i) less than 150 m<sup>3</sup>, (ii) from 150 m<sup>3</sup> to 500 m<sup>3</sup> and (iii) over 500 m<sup>3</sup>. While the wooden cages used in sheltered areas are usually home-made or purchased from local artisans, cages for semi-offshore conditions come from specialised companies, either Jet-Float (flexible preformed units) or Coralsea (circular flexible cages). Jet-Float cages (from 100 to 600 m<sup>3</sup>) are imported from Austria and Coralsea cages (from 500 to 1 800 m<sup>3</sup>) 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 m3	150 to 500 m3	> 500 m3
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 m3 each

#### 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 boat < 6 m no crane	flat boat without crane	flat boat 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

As for the impact on the environment, 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 contain precise information about :

- \* the use of the water and the free access to wild fish
- \* the devices preventing wild fish from going into the farm and farmed fish from escaping
- \* the general conditions of production in the farm
- \* 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 during one month. Then, a authorisation is given and the farmer commits himself to respect the quantity of water taken from the river, the free circulation of wild fish, the norms concerning the effluents and the measures for self-control. Among the difficulties in the implementation of these procedures, the major one is the evaluation of the impact on the environment because the methods to measure the effluents and to assess their becoming in the water are under scientific controversy. The main parameters considered for the calculation of the norms are suspended matter, nitrogen and phosphorus emission. The interpretation of the data is often contested by the pro-environment associations.

Moreover, marine aquaculture is concerned by the law about the use of the coast-line. This law is aiming at defining a special policy for the coast-line in order to conciliate development and preservation. But, although its text makes reference to the development of economic activities like aquaculture, it is very often interpreted in a rather protective meaning. As the marine area may not be owned by anybody but the State, the marine farms have to get a lease from the State, after an enquiry realised by the local Direction of Marine Affairs. The occupation of this public marine area is under strict regulation. These regulations describe the conditions to have access to a lease. In particular, the future farmer has to prove either experience in the field or having attended a specific formation. These leases are not free and a very complicated system of tax calculation has been enacted. These method of 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 the sea shore. The maximum duration of the lease is 35 years.

## **CONSTRAINTS, PROBLEMS AND REQUIREMENTS FOR THE DEVELOPMENT POTENTIALS OF OFFSHORE MARICULTURE IN FRANCE**

The major constraint in France is the access to space along the sea-shore. Indeed, there are convenient sites for fish farming in offshore and semi-offshore conditions, but they are submitted to severe use conflicts. Urbanisation, tourism, Navy, wildlife parks projects, harbours, boat traffic are as many competitors which are all the more serious as they have been there before aquaculture. Islands are usually less submitted to constraints due to town extension, industry development or intensive agriculture. So, in Corsica, many sites are easily available but they are often remote, far from any harbour and with a difficult access by road.

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 like in the salmon industry. But these cages are not easy to handle with small animals, and the trend is to do a pre-growing phase in inland structures in order to put animals over 50 or 100 g at sea. So, the on-growing phase would be less than one year at sea, reducing the risks and the labour costs. That is the reason why a research and development effort is done on intensive pre-growing in raceways, using recirculation. These two techniques, intensive inland raceways using recirculation and offshore cages appear as complementary for the further development of fish farming in France.

## CONCLUSION

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 a few years, by lack of new projects (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, Madera). Indeed, technical constraints have been recently 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 urbanised 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 cargoes, but has not yet valorised all the possibilities given by the new offshore technologies experienced by the salmon industry. The new project by Saetremyr, this Norwegian company which has bought out Salmona's plant in Cherbourg harbour should go along this idea with a project of a salmon farm in front of Marseille.

Scrutiny from the administration, controversial regulatory constraints and user's 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, the French enterprises suffer a 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 pre-grown juveniles in recirculation systems for a shorter cycle in offshore cages.

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