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# Marine fish farming in Spain

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**SUMMARY** – Spain, a country of age-old marine tradition, has a coast bathed by different seas (Atlantic and Mediterranean) and is endowed with different geographical characteristics that offer a wide range of possibilities as regards aquaculture potential. As in many other parts of Europe, Spain is now contemplating how its aquaculture production is rapidly expanding. Thus, although most production is molluscan shellfish, the production of marine finfish is increasing at higher rates and in 1998 reached 11,296 tonnes (an increase of 15% over the previous year). Marine fishfarming has been developed in earth ponds and tanks, and more recently in inshore or semi off-shore conditions. Nowadays, intensive farming is moving offshore towards increasingly exposed environments. As technical constraints are being overcome, the sector is looking for solutions for development in an environment where space is also sought for other activities, mainly tourism. This paper reviews the development of marine fish culture in Spain, giving information on marine finfish production and the size of marine farms, the comparative importance of different technologies, Spanish legislation on coastal and offshore culture and the constraints suffered by the sector.

**Key words:** Spain, marine fish farming, sea bream, sea bass.

**RESUME** – "Mariculture en Espagne". L'Espagne, pays de très longue tradition marine, possède un littoral baigné par différentes mers (Atlantique et Méditerranée), et présente des caractéristiques géographiques différentes qui offrent une vaste gamme de possibilités au potentiel aquacole. Comme beaucoup d'autres régions d'Europe, l'Espagne voit aujourd'hui une expansion rapide de sa production aquacole. Bien que la plupart de la production soit représentée par les mollusques à coquille, la production piscicole marine augmente à une allure croissante, ayant atteint en 1998 11 296 tonnes (15% d'augmentation depuis 1997). La pisciculture marine a été développée dans des étangs et des bassins, et plus récemment sur le littoral ou à proximité des côtes. Actuellement, l'aquaculture intensive se déplace vers la mer ouverte dans des sites de plus en plus exposés. A mesure que les contraintes techniques sont contournées, ce secteur se penche vers des solutions ou des développements s'inscrivant dans des milieux où l'espace est également convoité pour d'autres activités, principalement le tourisme. Cet article présente le développement de l'aquaculture marine en Espagne et fournit également des informations sur la production de poissons marins, la taille des exploitations piscicoles marines, la technologie utilisée et développée actuellement, et donne un aperçu de la législation espagnole et des contraintes du secteur.

**Mots-clés :** Espagne, mariculture, dorade, loup.

## Introduction

As in many other parts of Europe, in Spain, aquaculture and particularly that of salt water species, is nowadays perceived as the only means to preserve the present equilibrium between supply and demand of fish products for human consumption. This equilibrium has become increasingly more fragile for two main reasons: (i) the supply of fish from fisheries is practically stagnant and for some species it is actually decreasing; and (ii) the demand is constantly growing. This is not only due to the increasing human population but also to the changing diet preferences, from meat to fish (fish is healthier, has lower cholesterol content, etc.). Both the business world and consumers are awaking to the benefits of aquaculture and here is where the business sector finds a new and growing field for investment. The consumer is gradually coming to appreciate the qualities of this type of fish.

The marine fish farming industry in the Mediterranean basin is characterized by an amazing development over the last ten years with a production of sea bass (*Dicentrarchus labrax*) and sea

bream (*Sparus aurata*) – of 64,000 t in 1997 and estimated at 76,000 t for 1998 (FEAP: [www.feap.org](http://www.feap.org)). Nevertheless, it is still far behind the Northern European salmonid industry in terms of level of production, production costs and market internationalization. In Europe, 80% of the supply of sea bass and sea bream is now provided by the aquaculture sector. These two species are produced in more than 700 production units and about 90 hatcheries operating in 15 countries (Basurco, 1998).

In Spain, three factors in favour of the aquaculture sector are (CES, 1996):

(i) *Coastal characteristics*; given its extensive shore line, it has ample surface capacity to accommodate fish farming.

(ii) *Fish consumption*; Spain has one of the highest fish consumption rates in the world. Estimates place the consumption at approximately 42 kg/person/year placing it on a par with Portugal and Norway as the leading *per capita* – consuming nations in Europe, and second in the world only to Japan.

(iii) *Reconversion of the fishing sector*; although the Spanish fishing fleet is one of the largest in the world, its industrial and commercial fishing structure is running a high risk of deterioration due to the progressive reduction in its catch volume. In the face of declining fish stocks and increasingly negative attitudes towards granting or renewing fishing permits in countries where Spain traditionally used to make a high percentage of its catches, the risk of unemployment is very high in this sector. The aquaculture industry in Spain, a country of ancient marine tradition, might therefore be expected as an alternative source of employment in the fishing sector.

## Coastal characteristics

From the geographical point of view, Spain is one of the most privileged European countries. Its coast of almost 6000 km and its topographical characteristics offer the physicochemical and environmental conditions needed for present day aquaculture developments. The abundance of rivers, deltas, coves, bays, etc. offers a wide range of sites suitable for aquaculture. There are also floodable areas suitable for "valliculture". The topography also offers the possibility of economical pumping of sea water to on-shore fish farms, where the difference in level of the tides is not too high (Mediterranean), and aquifers permit the regulation of salinity.

The coasts of Spain also offer good opportunities for offshore aquaculture. However, the majority of suitable coastal sites for aquaculture cannot be used, either because of competition with tourism (the main source of national income) or due to the growing concern for the environment (i.e., most inland waters); since some of these areas suitable for aquaculture are exposed or sensitive, (lagoons, rías, bays, etc.). For these reasons, many existing marine farms (with the exception of turbot farms, saltpan-based units or concrete ponds) currently on-shore or in semi-exposed sites such as open bays, are seeking to expand in more exposed sites.

Although it is impossible to give precise details of the Spanish coast, probably one of the most variable within Mediterranean countries, some of its main characteristics are listed below. These particular features also point out the need to make detailed environmental studies for potential aquaculture sites on a national basis, and likewise highlight the importance of taking better advantage of all existing data to create a National Mariculture Database (see also Turner, this volume).

The Spanish coast is 5968 km long, 3904 km along peninsular Spain, 910 km around the Balearic Islands, 1125 km around the Canary Islands and 29 km in the African Territories. Most of the Spanish coast stretches along the Atlantic shelf and oceanic ridge, partly constituted by the 359 km of the Cantabrian coast, whereas the Mediterranean basin has a coast 2580 km long. The waters of the Atlantic and Cantabrian systems are very dynamic, with currents, tides, waves, etc. and an average salinity of 35-36‰, unlike the Mediterranean waters which are less dynamic, with negligible tides and higher temperatures with a salinity ranging from 37 to 38‰. In general, the temperature is warmer in the Mediterranean than in the Atlantic.

Bathed by different seas (Atlantic and Mediterranean), the Spanish coasts are endowed with different geographical characteristics, offering different opportunities for aquaculture. Thus, the

Atlantic coast can be divided into several categories: the Cantabrian, Galician and southwestern coasts. The first is rectilinear and longitudinal, with a sharp drop into the sea and many cliffs, few beaches, low coasts and small estuaries (rías). The Galician coast has many large estuaries: from the Rias Bajas (wide, deep, tortuous funnels ranging between 15 and 35 km long) to the Rías Centrales, which are sinuous, very open, small and almost as long as they are wide. Water temperatures may range from 12 to 22°C and offer good opportunities for the ongrowing of certain marine species, such as turbot. The southwestern coast, is a low coast with numerous river mouths: the Guadiana and Guadalquivir with many estuary areas with salt marshes. Many of these salt marshes were transformed and used as "esteros" (salt production ponds). Nowadays, some of these salt production ponds have been transformed in semi-intensive earth ponds, and on-grow sea bream at low densities (1.5 to 3 kg/m<sup>3</sup>) from juveniles either of wild origin or from industrial hatcheries. Thus, in the Bay of Cadiz 9 out of 127 salinas (about 600 ha) have been adapted for this use. Finally, also bathed by the Atlantic sea are the Canary Islands, which are of volcanic origin with rocky coasts. Waters, although oligotrophic, are warm all year long and may range from 17 to 24°C.

The Mediterranean coast also has very contrasting features. The northeastern coast (Catalonia), has: small coastal plains, coasts with cliffs and some deltas. The eastern coast, (Valencia) is characterized by the presence of a number of deltas stretching out into the sea, as well as sandy isthmuses uniting small rocky islands to the mainland. There are also many coastal lakes such as the albufera of Valencia. The south eastern and southern coasts (Murcia and Andalusia) are also very contrasted, with many cliffs alternating with long sections of low coasts, steep-sided torrential valleys and a narrow, almost continuous coastal plain. Mediterranean water temperatures may range from 11 to 26°C.

## Evolution of marine fish farming in Spain

Following Spain's entry into the EU and subsequent access to European support funds, marine aquaculture received significant support from the administration at the end of the 1980s. It did not however, come up to expectations. This was perhaps due to the lack of an appropriate R&D policy, or possibly to investment made in a business which at that time seemed exotic and heavily subsidized, through projects which had little hope of being economically viable.

However, Spain has now developed into one of the primary European aquaculture producers in terms of volume, where most of its production comes from bivalves. Thus, in 1998 marine fish production, at 11,296 t (Table 1), represented a small percentage in comparison with bivalve production (mainly mussels) of more than 200,000 t. Excluding mussel production, which has had specific problems, aquaculture production in Spain has undergone a rise of around 7% annually in recent years, and marine aquaculture has had a greater growth (15.5%) than that of land aquaculture, which has risen by only 3% (Ruiz Molina, 1997). Of the 1998 marine fish production of 11,296 t, sea bream was the predominant species, with 5530 t (Table 1).

Table 1. Marine fish production (Source: APROMAR<sup>†</sup>)

	Production (tonnes)										No. of farms <sup>††</sup>		
	1990	1991	1992	1993	1994	1995	1996	1997	1998	2000e	1990	1996	2000e
Sea bream	565	1073	1675	2210	2720	3300	4704	5530	6330	9000	46	40	55
Sea bass	31	92	143	390	610	654	904	829	1408	2000	15	9	15
Turbot	640	870	1050	1510	1515	1870	2020	2225	1850	2900	25	12	14
Salmon	355	553	782	562	909	695	726	800	800	1200	5	5	6
Eels	125	98	105	175	134	174	189	266	250	350	3	2	3
Others <sup>†††</sup>	504	112	163	143	162	155	149	150	108	500	7	10	10
Total	2220	2798	3918	4990	6050	6848	8692	9800	11296	15950			

<sup>†</sup>1998 data from production survey conducted by TROUW Spain. Official production figures are normally lower in general terms (8-10%); some species have particular differences up to 25%.

<sup>††</sup>Some farms cultivate sea bream and sea bass in the same facility, hence total is lower than sum.

<sup>†††</sup>Others: Sole, tuna, etc.

The development of marine fish farming has been based on a small range of species, mainly sea bream and turbot, and on a wide range of techniques, ranging from semi-intensive production in earth ponds to intensive cage culture in semi-offshore or offshore conditions.

After some years of stagnation or crisis during the early 90s, when a number of sea bream and sea bass farms failed (Table 1) in a "pioneer stage" crisis, the sector is now developing at a fast rate. Thus production is expected to rise to 11,000 tonnes or more in three years time, from 7738 t in 1998. During the early 90s many turbot farms also closed, unable to produce enough at a cost below sale price. However, production is now steadily increasing, with 2500 t recorded in 1998. Intensive farming of salmonids, mainly developed in Galicia, has not fulfilled early expectations and production has increased at a very slow rate. On the financial side, it would appear that the marine fish farming sector, and in particular sea bream and sea bass, will attract more investors, including some investment transfers from fisheries.

### Regional distribution of marine fish farming

Almost two thirds of the Spanish sea bream and sea bass production comes from the south, the Andalusia autonomous community (Table 2). There, half of the production, mainly sea-bream, is cultured in semi-intensive earth ponds adapted from salt production systems (Fig. 1). Besides Andalusia, production sites are found along the Mediterranean coast: Catalonia, Murcia, Balearic Islands and Valencia. The Canary Islands, with warm waters all year long ranging from 17 to 24°C, offer a good opportunity for ongrowing of sea bream and sea bass.

Table 2. Regional distribution of sea bream and sea bass, in year 1996 (Source: APROMAR<sup>†</sup>)

Regions	Number of units		Production (t)		Total production (%)	
	1996	1998	1996	1998	1996	1998
Cantabria-Galicia	1	3	0	20	0	0.3
Andalusia	18	18	3608	3969	64	51.3
Balearic Islands	2	2	220	200	4	2.6
Canary Islands	5	6	520	800	9	10.3
Catalonia	12	9	678	1310	12	16.9
Murcia	1	2	582	700	11	9.0
Valencia*	3	5	0	739	0	9.5
<i>Total</i>	<i>41</i>	<i>45</i>	<i>5608</i>	<i>7738</i>	<i>100</i>	<i>100</i>

<sup>†</sup>1998 data from production survey conducted by TROUW Spain.



Fig. 1. Semi-intensive sea-bream production in earth ponds in Andalusia (CUPIMAR, S.A.).

On the contrary, for turbot the whole production is carried out in the north, with farms all along the north, Cantabrian coast. This is due to temperatures, ranging from 12 to 22°C, which match those which are ideal for the species.

### Size of production units

A slight increase in size of the average production site has come about, both due to the development of the very big farms and to the expansion of the middle size farms. For seabream and sea bass, the clear tendency is to develop offshore cages in production units of 200 to 400 t capacity. In the next few years it is likely that there will be just a few units over 500 t, as companies may prefer to have several units of 300 to 500 t within a reasonable distance of each other, instead of one big farm. In this respect, new projects may target a profitable operating size of ~300 t production with about 12 cages. These units may subsequently grow to reduce overheads, to a size of 500 or 600 t. Although bigger units, i.e., 1000 t, may have lower overheads, this advantage may be reduced by much higher risk (Table 3).

Table 3. Sea bream and sea bass production units by class of size (Source: APROMAR<sup>†</sup>)

Production unit output size	No. units in year				Total number of units (%)				Production (%)	
	1990	1996	1998	2000	1990	1996	1998	2000	1996	1998
<30 t	39	21	15	10	84.7	53.4	33.3	15.4	51	1.9
30 t to 100 t	5	9	4	10	10.8	20.9	8.9	7.7	22	7.1
100 t to 200 t	2	6	11	16	4.3	13.9	24.4	30.7	15	13.6
200 t to 500 t	0	4	10	15	—	9.3	23.2	30.7	10	33.1
500 t to 1000 t	0	0	4	3	—	—	8.9	10.7	0	26.1
>1000 t	0	1	1	1	—	2.3	2.3	4.6	2	18.2
Total no. units	46	41	45	55	100	100	100	100	100	100

<sup>†</sup>1998 data from TROUW Spain production survey.

The only exception may concern existing projects developed in earth ponds. These projects will probably continue while profitable, but due to the substantial new investment costs there are unlikely to be many new projects in the near future. Likewise, the development of more concrete tank or raceway units is not envisaged.

As regards turbot, in recent years, with technological improvement and market price pressures, surviving farms have raised their break-even point for volume sharply; thus, today it is very difficult to find farms with an installed capacity of less than 150 t.

### Production techniques

When looking at the evolution of production techniques used for sea bream and sea bass farming in Spain, the only technique that is experiencing a clear expansion is that of cage culture in semi-offshore and offshore conditions (Table 4). Nevertheless, production in earth ponds (salinas) still accounts for 45% of total production (Fig. 1), and a single farm, Cupimar, produces about 20% (1600 t in 1998) of the total production. Since 1990, while production units in earth pond, raceway and concrete tanks have decreased, the number of units using cage culture has clearly expanded. Production in cage culture, which in 1990 represented only ~17% of total production (8 units), accounted for 56% in 1998 (23 units). Many farms using cages are implemented in semi-offshore conditions, and most of these are small-scale enterprises. The most popular systems are circular flexible cages, of ~16 m diameter, which represent ~60% of the cages used (Calvo, 1999). Spain has also seen some projects developed involving heavy and costly offshore platforms.

Table 4. Production techniques for sea bream and sea bass farming (Source: APROMAR)<sup>†</sup>

Production technique	Number of units			Total units (%)			Production (t)			Total prod. (%)		
	1990	1996	1998	1990	1996	1998	1990	1996	1998	1990	1996	1998
Earthponds (Salinas)	31	19	14	67.4	44.2	31.1	316	2550	2700	53.0	45.5	34.9
Pre-ongrowing in tanks	—	2	4	—	4.6	8.9	na <sup>††</sup>	na	na	na	na	na
Race-ways and concrete tanks	7	4	4	15.2	9.3	8.9	180	950	704	30.2	16.9	9.1
Cages in in-shore conditions	6	3	1	13.0	6.9	2.2	100	1070	600	16.8	19.1	7.7
Cages in semi-offshore and offshore conditions	2	15	22	4.3	34.9	48.9	—	1030	3734	0	18.4	48.2
<i>Total</i>	<i>46</i>	<i>43</i>	<i>45</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>596</i>	<i>5600</i>	<i>7738</i>	<i>100</i>	<i>100</i>	<i>100</i>

<sup>†</sup>1998 data from production survey carried out by TROUW Spain.

<sup>††</sup>na: not applicable.

Cage culture (Fig. 2) has been experiencing the largest development in terms of quantity over the last six years, and most new projects use this technique in semi-offshore or offshore conditions. In 1998 there were 23 cage units (18 in 1997) with 297 (244) cages, and an average of 12.9 (13.5) cages per unit. Installed capacity was 6430 t compared with 5280 t in 1997. It appears that more than 150 new cages will be installed in 1999 and 2000, thus increasing the capacity sharply, and emphasizing the dominance of this production sector in Spain.



Fig. 2. A cage fish farm installation off Gran Canaria (ADSA S.A.).

### Marine hatcheries

After the sectoral crisis of the early 1990s, only those hatcheries with high technology and good financial back-up survived. These hatcheries, together with the principal feed companies, have always developed their capacity well in advance of the needs of the Spanish market while exporting the surplus. Therefore the country is prepared to sustain a healthy growth in terms of availability of raw material. As shown below, exports have represented an important part of production in previous years, though this reduced significantly in 1998.

Spanish hatcheries produced ~45 million sea bream and sea bass juveniles in 1997 and 1998 (Table 5), the production of Cupimar and Tinamenor hatcheries alone being above 30 million, representing 70% of production. These hatcheries have well organized production plans, in order to guarantee supply according to market needs.

Table 5. Sea bream and sea bass fry production (Source: APROMAR)

Species	No. hatcheries			Production (million.)			Exports (%) <sup>†</sup>		
	1996	1997	1998	1996	1997	1998	1996	1997	1998
Sea bream	7	9	10	30.9	40	36.2	55	62	36
Sea bass	6	4	6	3.7	6	7.1	20	51	22
Total	8	10	10	34.8	46	43.3			

<sup>†</sup>Calvo, 1997; 1999 (pers. comm.).

In recent years an increase in pre-grown fry has been observed (10-15 g or more), which is partly due to the increase in cage culture systems. Thus in the last few years a number of companies have developed specialized nurseries, assuring tight contracts with the main hatcheries for the supply of 2 g juveniles. Of the 10 current hatcheries, 3 do not practice ongrowing, 7 do so, and 2 practice pre-ongrowing (Calvo, 1999).

### Production parameters

The biomass levels according to available volume show an average of approximately 10 kg/m<sup>3</sup> with variations between 8 and 18, where 15 kg/m<sup>3</sup> might be considered optimum for cage culture. In earth ponds, collected data give values varying between 0.2 and 2 kg/m<sup>2</sup>, in some cases 15 kg/m<sup>2</sup> (ProAqua, 1998). Ongrowing to commercial size (~350 g) normally takes about 16 months for sea bream and 20 months for sea bass in the Spanish Peninsula. In the Canary Islands, a target weight of 400 g is reached sooner, about 13 months for sea bream and 16 months for sea bass.

The food conversion factor based on 1997 data varied between 2.0 and 4.0 for sea bream and between 2.3 and 4.0 for sea bass, the weighted mean being 2.32 for sea bream and 2.41 for sea bass (ProAqua, 1998). A drop can be observed in comparison to previous years, due to a general improvement in husbandry, with a higher yield when working in batches.

Labour productivity is difficult to estimate and may vary greatly according to the production technique and the situation of the firm (i.e., whether expanding or consolidating). By way of indication, data presented by Calvo (1998) estimates that for a cage farm the average number of workers per cage is 0.59 (including technical staff, boat crews, divers, farm workers and security guards, but excluding post-harvest, i.e., packing, and other functions), with an average annual output of 25 t per worker. Here, the use of equipment to increase productivity may be a key issue, and it is notable that only 7 out of 23 cage farms had a vessel equipped with a crane for material and stock handling.

### Regulations for the establishment and operation of marine farms

Even though there is a general legal framework for aquaculture in Spain, which reasonably regulates inland and on-shore aquaculture, it is not sufficiently updated for off-shore mariculture practices, which have been developed much more recently and still have to be considered and understood in wider detail.

In Spain, aquaculture falls under the competence of its 17 autonomous communities, as for agriculture and fisheries. Thus, the two national laws regulating marine aquaculture are applied, just as with other specific normatives, i.e., environmental impact norms, under the responsibility of each autonomous community. These two main laws are the Mariculture Act (Act 23/1984) and the Coasts Act (Act 22/1988). The Mariculture Act ensures the regulation and planning of mariculture in Spanish territory, inland, in rivers, estuaries, lagoons and salt marshes, territorial waters and exclusive economic zone, both regarding public goods and private property without undermining the competencies and responsibilities of each autonomous community.

The purpose of the Coast Act is the determination, protection, use and surveillance of the public domain of the coast and the jurisdictional waters. The administrative action will also seek to protect the

integrity of the coast and its appropriate conservation and will guarantee the public use of the sea, regulate the rational use of these goods in accordance with the natural balance of nature, as regards landscape and environment, etc.

In compliance with these laws, each autonomous community will require a basic documentation when presenting an aquaculture project. The project should include: (i) a biological report; (ii) economic and financial study; (iii) technical report; (iv) plans of the site; (v) photographic study of the area; (vi) budget; and (vii) environmental impact assessment.

The request must be accompanied by 8 copies of the project, (number of copies varies with autonomous community), in order to be able to present the project to different institutions involved in its approval process: (i) Autonomous communities; (ii) City Councils; (iii) Naval Authorities; (iv) General Directorate of Fisheries; and (v) Ministry of the Environment, and others, depending on which Autonomous community is responsible for the request. These other bodies could include those involved in tourism, public health, agrarian reform, fishermen's guilds, etc.

Every autonomous community has issued its own complementary regulations, with different requirements and constraints. Investors thus find it more difficult to take decisions but new opportunities are created depending on the location selected.

As regards the granting of permission, this may vary in time (from 1 to 2 years average, project subsidies not included) and in form according to the autonomous community and the project. Project studies requested and bureaucratic procedures may vary according to the community and to the different institutions involved in their approval. This not only produces a delay in the granting of permits but may also be a barrier for possible investment.

Regarding leases or rights to use sites for marine aquaculture, these permits are temporary and are usually granted for a period of ten years, renewable for a new period of 10 years and to a maximum of 50. These permissions may also vary according with the autonomous community concerned. The payable rates, just as the permits themselves, may also vary, i.e., ranging from 1 pta/m<sup>2</sup> for the first 5 years as in Catalonia, Andalusia and Ceuta up to 587 pta/m<sup>2</sup> in some examples observed.

In this context, priorities, as seen by APROMAR, should be: (i) the homogenization of normatives of all different autonomous communities; (ii) centralization of the process of granting permission, through single departments or agencies in order to reduce bureaucratic procedures; and (iii) the updating of normatives considering aquaculture constraints and potentials as regards concessions, environmental requirements, etc.

A comparative study of the present-day legislation and its evolution in those countries which have achieved a better development in this sector, would prove very useful in developing guidelines to improve the Spanish legislation. For instance, the accelerated development of the salmon industry in Norway was fostered by a very supportive legal and fiscal environment. In Chile, marine aquaculture has been very successfully promoted simply by unifying all the legislation concerning aquaculture in just one legislative body and by establishing a single access "window".

## Financial aid

As regards financial aid, the Spanish aquaculture sector has benefited from European subsidies following the entry of Spain into the EU in January 1986. The EU has considered aquaculture as a high priority activity and all European Community norms and regulations are written to this effect (Ariño, 1997). The financial participation of the European Agricultural Guidance and Guarantee Fund (FEDEGA) and from 1994 onwards, the Financial Instrument for Fisheries Guidance (FIFG) requires that each project of public, semi-public or private investment related to the construction, equipment or modernization of aquaculture facilities is presented within the framework of a Pluriannual Orientation Programme. Based on these provisions, the Ministry of Agriculture, Fisheries and Food drew up the 1994-1999 Sectoral Fishing Plan for Spain, establishing the lines to be followed, the distribution of aid, and the subsidies funded by the central and regional administrations.

In the period 1986-1993, a total of 453 aquaculture projects were approved (mussels being the principal product granted) with an investment value of 10,568 million ptas. and from 1994 to the end of 1997, projects approved for a value of 2335 million ptas.

## **Supporting infrastructure**

Aside from the companies mentioned in the chapter on technology used for Offshore Mariculture in Spain (Basurco *et al.*, this volume), many may also provide project assistance to fish farm companies, other companies also operate in and provide support to the sector.

### **Aquaculture feed manufacturing companies**

Due to restructuring in the sector, as elsewhere in Europe, there are now only 3 such companies left in Spain: TROUW (Nutreco group), ProAqua (former EWOS and now within the Provimi group) and DIBAQ (Spanish company). Other European companies sell feeds in the Spanish market, but with a small market share.

Besides selling aquaculture feeds, these companies also provide consultancy services to farmers, i.e., disease diagnosis and production management advice. As regards R&D, although these companies have no major research stations in Spain, they may either belong to a multinational group with their own research station in another country, as is the case of TROUW, or may have research project agreements with established Spanish research groups.

The option of having a feed company participating in a production integration "project" may be more frequently observed in the years to come.

### **Producers association**

APROMAR (Asociación Empresarial de Productores de Cultivos Marinos) was born from the producers' need to coordinate actions to solve their problems. Its main tasks are: (i) to be a valid interlocutor before different administrations; (ii) coordinate market actions to defend the production value of the associates; (iii) bring forward to the producers all information available; (iv) face common problems together, i.e., insurance, R&D, environmental investigation, labour laws, etc.; and (v) promote sectoral and specific studies and research

In accordance with the political structure of the autonomous communities, the sector has developed several regional associations, all of them included within the APROMAR framework, that deal with local authorities. This is the case for AROGA, ACEA and ASEMA.

### **Consulting**

The rapid growth that the sector is currently experiencing, with some 15 new cage projects coming in and the growth of several existing projects, has undoubtedly been dependent on the inputs and great field expertise of a group of skilled and trained national consultants. The 2 principal groups are COREMAR (Luis Cabello) and the group belonging to Jordi Carreras and Jordi Carmona.

### **Research and development**

In matters of scientific research in the aquaculture sector, as in other sectors in Spain, there are two related constraints: on the one hand, coordination is lacking between public research organizations and the private sector and, on the other, the participation by the private sector in the scientific policies that would permit technological development responding to real and current needs. In this sense, the sector should more actively participate in the National Agricultural Sciences Plan so that the research lines demanded by the sector can be promoted.

Within this context, besides the research carried out in some private companies (most information already presented above and elsewhere), various public institutions work in different fields of aquaculture, such as:

(i) *Spanish Institute of Oceanography (IEO)*, with centres in Vigo, Santander, Tenerife and Mazarrón.

(ii) *The Higher Council of Scientific Research (CSIC)*, with centres in Barcelona, Cadiz, Torre de la Sal, and Vigo.

(iii) *Universities*: Santiago de Compostela, Lugo, Oviedo, Vigo, Cadiz, Murcia, Valencia, Barcelona, Las Palmas de Gran Canaria, Balearic Islands, among others.

(iv) Centres of Research and Development which depend on the autonomous communities: Canary Institute of Marine Science (Canary Islands), National Aquaculture Centre (Catalonia), Centre of Mariculture and Centre of Aquacultural Experimentation (Galicia) among others.

The Centre for Technological and Industrial Development (CDTI - Ministry of Industry and Energy), provides soft credits to finance projects either for individual companies or companies in association with research institutions. This supports projects whose purpose is the development of products or technologies, or the improvement of existing approaches towards greater productivity of the sector.

In addition to the above, the "Junta Nacional de Cultivos Marinos" (JACUMAR), is responsible for co-ordination of administrative action concerning aquaculture. This national body, recently created and with a great potential, is a permanent framework for the discussion of problems affecting more than one administration (e.g., introduction of foreign species, disease control, etc.) or for the exchange of information which favours a rapid dissemination throughout the whole of Spain of any technical progress achieved in any national or foreign centre, and to distribute the funds available through the FIFG mechanisms.

## **Relationships between aquaculture and fisheries**

Spain is a country of age-old marine tradition that has seen how aquaculture and fisheries in most cases only come together in the market. A country with a high fish consumption per capita (about 42 kg), it has an ancient tradition in fisheries. Thus, Spain has one of the biggest European fleets, which traditionally fished in foreign waters. As these possibilities diminished, so have the catches, giving rise to the consequential crisis. To this effect, there now are some examples through which the fishing sector seeks solutions through aquaculture, and Spain is now witnessing some transfer of investment from the fisheries/capture sector to aquaculture. One such case is that of PESCANOVA, one of the biggest fisheries companies in Spain. Another is the aquaculture activities promoted by the Fishermen's Associations in Catalonia.

The PESCANOVA group, a company owning a fleet with processing facilities and marketing units, created an aquaculture section, ACUINOVA, at the beginning of the 1990s. This group grows shrimp (*Penaeus japonicus*), turbot, and sea bream and also has a hatchery for turbot and sea bream. The group, which has units in Cadiz and Galicia, has now launched an expansion plan and is investing in new projects such as the establishment of a sea bream on-growing unit in Huelva (Andalusia).

### **Relationship with local fisheries**

There are also cases of fishermen's associations and other associations of the fishing sector participating in aquaculture projects. Thus, in Catalonia, probably the Autonomous Community with the most aquaculture projects, 8 out of the 32 existing Fishermen's Guilds participate in fish cage farms (Jordana, 1999). As illustration, the cases of Blanes peix and cultimar are described below.

**BLANES PEIX.** The Blanes project began at the beginning of the nineties, entering into production in 1993. The Fishermen's Guild of Blanes, Girona, Catalonia participates in this project. The project was set up as a medium to small-sized production unit which has gradually grown to produce about 100 tonnes in 1997. It is to be highlighted that most of the workers belong to the Guild, some have

been fishermen and that the marketing, although separate from the fishery products, is carried out using the facilities of the Guild.

CULTIVOS MARINOS DEL MARESME, S.A. was founded in December 1992. Shares were held by the Cofradía de Pescadores (Fishermen's Association) of Arenys de Mar, the Fishing Cooperative "Reyes Católicos", the Shellfishermen's Cooperative, the Shipowners' Cooperative "San Telmo", the Territorial Union of Sea Cooperatives of Barcelona (UCOMAR, SCCL, the oldest active cooperative in the fishing sector, more than 40 years old) and Ecos Risk Capital, SCR, S.A.: (the only Risk Capital Company, created by the Ministry of Employment, with the purpose of investing in projects representing Social and Economic development, as in this case). The project has represented an investment of more than 400 million pesetas, 20% of which has been granted as a life annuity from the old FEOGA (European Agricultural Guidance and Guarantee Fund). The farm started its operation in 1996 and expects to produce about 500 tonnes in 1999.

## **Marketing of marine fish**

Mediterranean marine fish farming has focused so far on the market for fresh seafood because of high production costs. Now, thanks to well-equipped fresh food counters, super/hypermarkets have proved to have positive effects on fresh fish sales in countries or regions where fresh fish consumption was traditionally low (Paquette, 1998). In Spain, where fish consumption rates are the highest in the region and traditional outlets are still dominant, some of the most important issues, as in other European countries are; the fast increasing role of supermarkets in the distribution chain, the development of new processing techniques and products like pre-packed fresh fish, and the growing importance of catering and the evolution of the consumer's behaviour.

As regards the distribution channels for marine aquaculture fish, most of production is commercialized through wholesalers (MERCAS and distributors hypermarkets) and only a small percentage ( $\leq 10\%$ ) goes directly to fishmongers and restaurants. Commercialization through MERCAS still represents the highest percentage of output, about 50%. The growing importance of hypermarkets is highlighted; whereas about five years ago these products were hardly sold, they now represent approximately 10-15% of total sales. At final consumption, about two thirds is consumed in restaurants and one third in the home.

In Spain, with the development of the sector, the actual size of the product has evolved to a bigger fish, thus approaching a product nearer to consumer preferences. Sea bream has increased from 330 g to a present size of more than 400 g. Sea bass are grown to 450 g, and consumers are willing to pay more for turbots weighing 2 to 3 kg. Aquaculture products appear to be able to maintain their current fresh presentation, appealing to the consumers' inherited perception of freshness equalling health and quality.

The quantities that have been put on the market until now have been achieved without proper budgets specifically devoted to marketing. Spanish fish farming has changed from being net exporters to net importers of aquaculture products as prices have become increasingly affordable for the middle class population. With the future in mind the Spanish producers, APROMAR – with the invaluable back up of FROM, Ministry of Agriculture – has now started a 3 year programme of market communication. This has the aim of educating the consumers, letting them know that for instance, 4 of every 5 sea breams consumed are now farmed, and that these aquaculture products have the highest quality standards.

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