THE ECONOMIC AND SOCIAL RESEARCH INSTITUTE

Memorandum Series No. 150.

AQUACULTURE: ITS PROSPECTS FOR THE 1980s

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April 1982

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AQUACULTURE: ITS PROSPECTS FOR THE 1980s

Aquaculture, more commonly known as fish farming, is the artificial rearing of fish; when the operation takes place in the sea it is called marine aquaculture or mariculture. Freshwater fish such as trout, catfish and carp have a long history of successful farming. The culture of marine species is, however, a relatively new area, technology is now, however, at the stage where a small number of species can be raised commercially. Ireland has lagged behind the rest of Europe in the development of aquaculture with little significant progress before the 1970s. Interest in aquaculture may have been stimulated by the flurry of official reports on the subject, American Survey Team (1964), National Science Council (1974) and Organisation for Economic Co-operation and Development (1975). Important groundwork had already been laid by the activities of a number of research organisations notably at UCG's shellfish research laboratory at Carna. What is certain is that the last five years have seen the launch of a large number of important new aquaculture ventures.

With the recent preparation of the NBST plan for the industry (NBST, 1981) it seems an appropriate occasion to review progress in the field over the last decade or so and to examine critically its prospects in the 1980s. In preparing this review we have drawn very heavily on two recent consultants' reports, Glude (1979), and Landell/Mills (1980), prepared for BIM.

The paper is organised as follows: the first section presents a brief outline of the legal and institutional framework within which the industry operates. Then the Irish experiences with some of the more important species are considered along with their prospects for the future, and finally we examine in detail some aspects of government policy towards the industry.

The Legal Base and Institutional Framework for Aquaculture

The Fisheries Act 1979, provides that aquaculture can only be conducted under and in accordance with a fish culture licence, an oyster bed licence, a licence granted by the Minister under Section 51 of this Act, or an oyster fishery order. Aquaculture has been defined in this Act to include the culture of any species of fish, aquatic invertebrate animals of whatever habitat or aquatic form, or any food which is suitable for the nutrition of fish. The Act provides for penalties where "a person by trespass, fishing or otherwise intereferes with anything done pursuant to an aquaculture licence".

Activities related to aquaculture are included in the programmes of several agencies, boards, semi-State bodies and universities. A short summary of the more important organisations and their responsibilities follows:

(1) Department of Fisheries and Forestry: The Department has the general responsibility for management of aquatic resources and policy generally. It is empowered to license fish and shellfish farms and to provide technical assistance in the areas of biology, ecology, etc. (The Department also has the authority to designate certain areas as suitable for development.)

(2) Bord Iascaigh Mhara: Distinctions between the role of BIM and the Department of Fisheries and Forestry with respect to aquaculture are not as clear-cut as one might wish. Nevertheless, some specific functions are clearly reserved to BIM. These include:

(a) Training potential aquatic farmers: During the pilot development stage an individual, who has obtained the necessary licence, will receive training and experience in the culture of selected species and in marketing and business aspects of aquaculture.

(b) Providing technical assistance to aquatic farmers: After a full commercial scale project begins, BIM will provide technical assistance or extension services concerning design and operating of culture systems, processing and marketing.

(c) Providing financial assistance to aquatic farmers: BIM, as the national grant giving body, will evaluate licensed projects and provide, or assist in obtaining, financial aid for those that are approved. Grants for capital expenditure from BIM and EEC can range from 30 to 60 per cent, with a maximum of IR £175,000 from BIM. The Board will also provide limited financial assistance for the purchase of seed, construction of pilot scale culture facilities, and for training courses or study tours of successful aquatic farms in Ireland or elsewhere.

(d) Providing for market development: BIM has the responsibility of improving markets at home and abroad for Irish aquacultural products.

(3) Údarás na Gaeltachta (formerly Gaeltarra Éireann): Its functions in promoting aquaculture parallel those of BIM and the Department of Fisheries. Its activities are limited to Gaeltacht areas. The Údarás has, however, taken the initiative in directly setting up aquacultural ventures. In 1975 it established Beirtreacht Teo to develop commercial shellfish farming. This company has since then undertaken very extensive trials in the mariculture of oysters and mussels. The Beirtreacht shellfish hatchery, located at Carna, Co. Glaway, is the first commercial hatchery of its kind in Ireland, currently employing 45-50 people.

In 1976 the Údarás, in collaboration with the ESB, established a second fish farming subsidary, Bradan Mara Teo, to develop the commercial farming of trout and salmon in the Gaeltacht.

(4) The Universities: The main facilities for aquacultural research are centred in University College, Galway. The faculty group concerned engages in research in genetics, pathology, nutrition, etc. Its shellfish research laboratory at Carna Co. Galway has a staff of about 30 people and provides technical advice of all kinds for commercial operators. A degree in Fishery Sciences in UCG, suitable for management personnel is under consideration, while a training course leading to a national certificate in aquaculture has been developed by Galway Regional Technical College.

(5) National Board for Science and Technology: The prime responsibility of NBST is the co-ordination of scientific and technological work in Ireland. The NBST has taken the major role in the formulation of a draft mariculture development plan. It has also commissioned a number of research projects. For example, it initiated a site selection study in 1978 to assemble data in respect to areas of the Irish coastline with mariculture possibilities. The NBST is empowered to take interim actions in areas not covered by other agencies, such as providing regional site survey officers to assist potential aquatic farmers to select appropriate locations.

Commercial Ventures

In recent years a large number of new aquacultural ventures have been launched, most of which are still in the preliminary development stages. In addition, other projects are planned. In this section we try to present, as far as possible, a realistic assessment of the potential of the various enterprises. The conclusions must, at best, be very tentative. Whether in any case a project is feasible or not can be ascertained only after a detailed financial/economic analysis, which as yet exists for only a few ventures.

Mussels

Mussels are grown by two systems in Ireland, (1) culture on the bottom, and (2) culture suspended below rafts. Culture on the bottom, as is done in Wexford consists of dredging seed mussels from their seed beds and transplanting them to "shallow" areas within the harbour. The method produces large mussels with good meat yield suitable mainly for processing. Their prices, are, however, much lower than those received for mussels produced by raft culture. The economics of bottom culture of mussels have been analysed and the process would appear to be commercially viable. Considerable scope exists for further expansion of this method at various sites along the southeast and southwest coasts, presently under investigation by BIM.

In the raft culture method, seed mussels are collected, usually on ropes, in settling areas and grown to market size elsewhere, (largely along the west coast). The technique produces a thin shelled mussel with a high meat yield. Beirtreacht Teo have been the pioneers in applying this method in Irish waters. Production was 180 tonnes in 1980, and it is hoped to reach 1,500 tonnes by 1986. The raft cultured mussels are sold in France during the winter months when the French supply of high quality mussels is exhausted. Because of the speciality market, they fetch up to £400 per tonne compared to the £50 per tonne for mussels produced on bottom in Wexford Harbour. Culture methods are still being modified and production has not reached a level that would permit a sound economic analysis. Mussels produced in Ireland by raft culture take longer to grow (two years compared with 1-2 years) and yield less (20-15 per cent) less than mussels produced by similar methods on the Continent. Since the Consultants' Report (Landell/Mills, 1980) found that despite significant state subsidisation profitability was quite low in the Spanish industry, considerable doubt must exist whether the raft culture system will be profitable in Ireland.

Table 1 gives NBST figures for production of mussels in Ireland for 1977 to 1980 and projections to 1983.

Oysters

The Irish potential for oyster production has been long recognised, but to date progress in developing commercial operations has been slow. The American Survey team in 1964 suggested that a production of 30-35 million oysters could be forthcoming within 10 years. The ostrea edulis or flat oyster reproduces naturally in some areas in Ireland (including Tralee, Clarinbridge, and Kilkieran, Bertraghbuoy, and Aughinish Bays). Higher yields than at present could be obtained from the natural oyster beds with improved management, and the problem is now being tackled with the help of BIM (NBST, 1981). The demand for edulis oysters is very strong, particularly on the French market. Irish oysters are apparently free from the Aber and other diseases which have inflicted great damage on continental production and good growing conditions exist in a number of sites. Rates of return are potentially large. Initial capital investment in flat oyster culture is moderately high, since the oysters grow slowly, reaching market size only after four years or more. Raft culture may be helpful in reducing growing time and the cost of predator control, but it requires additional

Table 1: Production of cultured mussels in Ireland, 1977 to 1979 and projections to 1983

Year	Raft Cultured		Dredged		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
	Tonnes	£	Tonnes	£	Tonnes	£
1977	10	2,500	2,762	138,100	2,772	140,600
1978	75	26,250	2,670	133,500	2,745	159,750
1979	124	49,600	3,170	158,500	3,294	208,100
1980	179	71,600*	4,000	200,000*	4,179	271,600*
1981	706	282,400*	4,000	200,000*	4,706	482,400*
1982	892	356,800*	4,000	200,000*	4,892	556,800*
1983	1,167	466,800*	5,000	200,000*	6,167	666,800*

Note: * Projected values for 1980-1983 based on 1979 prices, i.e., £400 per tonne for raft cultured mussels and £50 per tonne for dredged.

Source: National Board for Science and Technology (NBST), 1981.

investment in racks and trays. The principal obstacles facing the flat oyster industry is the absence of a stable supply of seed at reasonable prices, and continuing high oyster mortality (NBST 1981).

The Pacific oyster, crassostrea gigas, does well in Ireland and has much lower production costs than the ostrea edulis. It is unlikely that it can reproduce naturally because of low summer temperatures in Irish bays. While this imposes the necessity for finding hatchery sources for spat, it eliminates the threat of displacement of the native flat oyster by the lower priced Pacific. Gigas oysters are much less popular with consumers as they lack flavour and are more difficult to open. Prices are low at the moment and Irish producers can expect very strong competition from continental producers. Thus it would seem that the Pacific oyster offers less favourable opportunities than the flat oyster.

The expansion of flat oyster production in Ireland, both from natural sources and by means of culture, deserves a high priority, as the market prospects are good and Irish production potential is substantial. Figures for the production of cultured oysters in Ireland for the years 1976 to 1980 and NBST projections to 1983 are provided in Table 2. These figures exclude the production from traditional operations which accounted for 770 tonnes in 1978 valued at around £1 million. There has, however, been a massive drop in traditional production since 1978, due to over-fishing.

Trout

Rainbow trout have been grown in freshwater farms in Ireland for many years and currently seven are in production. Total output was nearly 400 tonnes in 1980. There is no doubt that substantial technical scope exists for further expansion but the returns from freshwater trout farming appear to be modest, and insufficient to encourage increased investment. Good sites are also scarce since very large quantities of flowing water are required. Thus without an increase in the real price of trout (which appears improbable) or a change in technology, we are unlikely to see large increases in the output of freshwater trout. There is, however, much interest in the new technique of rearing rainbow trout in floating saltwater cages, developed originally by the Norwegians. Pilot schemes have been set up by Beirtreacht Teo, and Carraun Fisheries, and at least four others. The growth rates of these trout appear to be marginally higher than in freshwater, more importantly the flavour of the

Table 2: Production of cultivated oysters in Ireland, 1976 to 1979 and projections to 1983

Year	Crassostrea Gigas		Ostrea Edulis		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
	Tonnes	£	Tonnes	£	Tonnes	£
1976	6	7,500	10	8,750	16	16,250
1977	9	13,980	5	6,500	14	20,300
1978	14	26,250	10	22,500	24	48,750
1979	23	46,960	12	34,500	35	81,460
1980	65+	129,360*	13+	32,400*	78+	161,860*
1981	81+	162,640*	20+	50,000*	101+	212,640*
1982	123+	246,560*	227+	567,500*	350+	814,060*
1983	124+	248,800*	296+	740,000*	420+	988,800*

Notes: + Based on 12,500 oysters to a tonne.
* Proposed values for 1980 to 1983 based on 1979 prices.

Source: National Board for Science and Technology (NBST), 1981.

sea reared trout is said to be markedly superior. The question of whether an adequate return on investment can be achieved depends crucially on how successfully a market for this virtually new product can be created. Norwegian production was estimated at around 2,700 tonnes in 1980. Over 100 tonnes were produced in Ireland in 1980, mostly on the west coast.

As yet no economic analysis of the viability of salt water trout farming has been made. Table 3 gives NBST figures for the production of farmed sea trout in Ireland for 1977 to 1979 and projections to 1983.

Table 3: Production of farmed rainbow sea trout in Ireland, 1977 to 1979 and projections to 1983.

Year	Quantity	Value
	Tonnes	£
1977	7	15,400
1978	31	68,200
1979	60	132,400
1980*	122	258,400
1981*	332	730,400
1982*	400	880,000
1983*	500	1,100,000

Note: * Projected values up to 1983 based on 1979 prices.

Source: National Board for Science and Technology (NBST), 1981.

Salmon

Of the annual total production of 12,000 tonnes of Atlantic salmon, almost 25 per cent is supplied by fish farmers, mainly from Norway and Scotland. By the end of the 1980s it is expected that farmed salmon will account for most of the market. Up to recently, it was expected that salmon demand would continue very strong and that the market could absorb the projected large increases in production without any significant decline in price. Imports of large quantities of Pacific salmon in 1980, however, depressed prices considerably and the outlook for farmed salmon is not as good as it appeared in the past.

Pacific salmon is used mainly for canning and smoking and is therefore not competitive with Atlantic salmon on the fresh market. Despite this the large quantities of Pacific salmon taken (over 400,000 tonnes per annum) are bound to affect the European fresh market to some extent.

For many years the rearing of salmon smolts for restocking purposes has been carried out by the Electricity Supply Board (ESB) at their Parteen and Carrigadrohid hatcheries and by the Salmon Research Trust in Co. Mayo but it was not until 1974 that trials were conducted on rearing salmon to market size. Following sea cage trials at a number of locations by BIM, ESB, and the Salmon Research Trust, commercial operations were established.

Bardan Mhara Teo, established jointly by the ESB and Gaeltarra Éireann in 1976, produced its first commercial crop in 1978. Curraun Fisheries, financed by Arthur Guinness Son and Co. Ltd., produced a few tonnes in that year also. Both of these concerns are also rearing sea trout. All cultivation in Ireland, to date, has been carried out using floating cages. However the recent consultants' report (Landell/Mills, 1980) suggests that the shore tank method (i.e., where salmon are reared in land based tanks, ponds or raceways) may be better suited for Irish conditions. To date, only one such unit, Kealincha Salmon Ltd. Eyeries, Co. Cork has been established in Ireland.

Table 4: Production of farmed salmon in Ireland, 1977 to 1979 and projections to 1983

Year	Quantity	Value
	Tonnes	£
1977	10	33,000
1978	10	33,000
1979	13	48,750
1980	21	78,750*
1981	66	247,500*
1982	185	693,750*
1983	330	1,237,500*

Note: * Projected values based on 1979 price of £3.75 per kg.

Source: National Board for Science and Technology (NBST), 1981.

Few locations exist in Ireland which are suitable for cage cultivation, as the method demands a large amount of space, good protection from wind and waves, with a suitable depth of water and a strong tidal action to help removal of wastes. All in all, Údarás na Gaeltachta suggests that only 10-15 good sites are available. The ESB has now established an operation in Mulroy Bay off Donegal but results from it are not yet available.

Irish production costs are still high, smolt and salmon seed are expensive. In addition, farmed salmon have tended to receive lower prices than those paid for wild stocks, because of difference in texture, colour and taste. However, the quality of farmed salmon has increased enormously in the last few years and there is quite a good chance that the differential will eventually be removed. A more serious problem for the Irish producer has been the tendency of Irish stocks to reach sexual maturity at a very early stage, thus retarding growth. The problem would seem to be that the Irish wild strains used to produce the smolts are inferior to those used in Norway and Scotland. It has been tackled by a programme of selective breeding to improve the stock. A much quicker method would be the importation of Norwegian or Scottish eggs, but such a policy would incur the risk of importing disease into Ireland.

It is unlikely that Ireland could, or should, take the risk of pen-rearing Pacific salmon from US or Canadian sources. Although these fish, particularly Coho and Chinook, are easier to raise in captivity than Atlantic salmon, they command lower prices on European markets and might pose serious dangers to native stocks if they should escape and become established in Irish streams.

The two Reports, Glude (1979) and Landell/Mills (1980) consider other species (e.g., eels, turbot, clam, flatfish, obolane). While such species may well be candidates for aquaculture in the more distant future, their immediate relevance seems much less than the species already discussed except perhaps in warm water acquaculture discussed below.

Warm Water Aquaculture

Much research has accumulated over the last decade on the use of warm water (including the use of effluent from power stations and other industrial plants in aquaculture). This is an area which is not covered in the NBST draft Programme. Using warmed water can boost the growth rate of many species in addition to allowing the all-year

cultivation of many fish which cannot be reared under normal water conditions. Candidates suitable for the technique include Catfish, Trout, Carp and Eel. The fish are reared either in net cages in which case the effluent is released directly into some body of water or more commonly in raceways or concrete tanks.

At this stage Eel culture would seem to be the most promising species under Irish conditions. There is a strong market for Eels and good local sources of high quality elvers (Landell/Mills 1980). The ESB is currently investigating the possibilities at a number of stations. A privately owned Eel Farm in Kerry is, to the best of the authors' knowledge, the only other such undertaking in Ireland. This field is clearly still in its infancy, and its long run potential is unclear. However, progress in this field should be monitored closely with an eye to possible Irish application.

The Future of the Industry

The NBST document contains detailed projections of output and employment in the industry up to 1985 which are presented in Tables 5 and 6.

Table 5: Projected output of aquaculture (volume and value) according to species for 1980, 1983 and 1985

Species	*1980*		*1983*		*1985*	
	Quantity	*Value**	*Quantity*	*Value**	*Quantity*	*Value**
	Tonnes	*IR£*	*Tonnes*	*IR£*	*Tonnes*	*IR£*
Atlantic salmon	21	78,750	330	1,237,500	1,500	5,250,000
Sea reared rainbow trout	122	268,400	500	1,100,000	1,500	3,375,000
Freshwater rainbow trout	368	478,200	450	585,000	500	650,000
Oysters (extensive culture)	300	750,000	500	1,250,000	800	2,000,000
Oysters (intensive culture)	78	161,860	420	988,800	600	1,500,000
Mussels (extensive culture)	4,600	200,000	5,000	250,000	6,000	300,000
Mussels (intensive culture)	179	71,600	1,167	466,800	2,000	800,000
Total	5,068	2,008,810	8,367	5,878,100	12,000	13,875,000

* Values are at 1979 prices

Source: National Board for Science and Technology (NBST), 1981.

Only four species (salmon, trout, oysters and mussels) are seen as being produced in significant quantities up to 1985, probably a reasonable assumption in Irish circumstances. The difficulties involved in making long-term projections of output and employment are well known, but these projections should be reasonably reliable, at least up to 1983 as they are based on current plans.

The projections see the output of the industry increasing rapidly over the next few years, reaching 13,000 tonnes by 1985 (equivalent to an annual growth rate of 21 per cent per annum). The value of this production at 1980 prices increases even faster, from IR £2 million in 1980 to IR £14 million in 1985 (an annual compound rate of increase of 47.2 per cent). The bulk of the increase in value is accounted for by Atlantic salmon and sea reared rainbow trout which together account for 60 per cent of the value of the industry in 1985 compared with 25 per cent in 1980. Thus the projections are crucially dependent on the success of these two species for which a complete commercial analysis is not yet available. Large increases are also projected for the output of oysters and raft cultured mussels. The NBST also sees the price of all species being maintained in real terms, again a very strong assumption.

Table 3: Estimated employment in Irish aquaculture with projections for 1983 and 1985

Type of work	1980	1983	1985
Production: full-time	139	214	310
Processing	103	145	170
Research and development	80	100	150
Total full-time employment	322	459	630
Production: part-time	822	1,200	1,500
Total	1,144	1,659	2,130

Source: National Board for Science and Technology (NBST), 1981.

Future employment will depend, not only on the total output of the industry, but also on the species cultivated and the farming methods used. The NBST projects full-time employment in all activities connected with the industry increasing by 96 per cent to 850. Perhaps surprisingly they see part-time employment increasing by 83 per cent to 1,500 by 1985. Part-time production refers mainly to seasonal employment (in most cases on the oyster grounds). These employment projections seem over-optimistic particularly so for part-time employment. It is hard to see either a significant increase in seasonal employment on the oyster beds or the development of a large number of small part-time enterprises in a field where initial capital requirements are quite high, and whose technical complexity increases each year. This statement does however require some modification. The speed of aquacultural development and the shape this development takes will be influenced to a large extent by the activities of the government, a subject to which we now turn.

The Role of the State in Promoting and Planning Aquacultural Development

Currently the government assists the industry through a wide variety of measures, varying from the provision of direct financial assistance to a programme of research and development, undertaken by various State and semi-State bodies. The direct financial aid (administered by BIM and Údarás) is of two kinds.

(a) Grants for pilot schemes, to allow operators to initiate new schemes and determine their commercial viability (to an upper limit of IR £10,000).

(b) Expansion grants of 10-30 per cent of the capital cost of the enterprise are available once its economic viability is established by BIM. (The lower limit applies where projects also receive EEC aid.) It is mandatory that grant assistance is also sought from the European Agricultural Guidance and Guarantee Fund (FEOGA). Grant aid for approved projects from this source can be up to 50 per cent of capital expenditure. However, the value of FEOGA aid is reduced by the long delays in approving finance (up to three years). A shortening of this lag must be a top priority with BIM.

Aquaculture is a very research intensive activity, and the success of the Irish industry will depend very heavily on the quality of the work done in this area (i.e., disease control, selective breeding, etc.). The NBST estimates that State and semi-State bodies spent IR £700,000 on research and development in 1980 (NBST, 1981) and it is expected that this scale of expenditure will have to be continued for

some future years. The question then arises as to how these services can be best provided. The development work is best done as at present by BIM, Údarás na Gaeltachta, the ESB and the Salmon Research Trust but the basic research being done by the Department of Fisheries will need to be supplemented by some other organisation. It has been argued in more detail elsewhere (O'Connor et al., 1980) that the most satisfactory solution would be the creation of a central marine research unit with overall responsibility for aquacultural research. UCG would seem to be the obvious location for such an institute.

Some comments are also necessary with regard to the plans for the future structure of the aquacultural industry. We are at about the same stage as the Norwegians were in 1970 and like the latter we must decide now on the path we wish to follow. There are at least three alternatives.

(1) A small number of large scale projects (i.e., the Scottish model),

(2) A large number of small scale projects (i.e., the Norwegian model), and

(3) A possible combination of (1) and (2).

Left completely to itself, aquaculture would probably follow (1), because in an increasingly high technology and competitive industry, small firms and co-operatives would probably find it very difficult to compete. A policy of support for large firms could however arouse considerable local resentment since it would not necessarily benefit the people in the areas concerned and might even inhibit their traditional fishing operations. These people are likely to demand some share of the industry, and the next decade will see increasing pressure on the government to support small producers and probably to inhibit large firms by placing upper limits on production, as in Norway, or by demands for outright restriction on large companies.

The encouragement of small locally owned enterprise in depressed areas is, of course, a legitimate and laudable aim of government policy but whether it should be adopted for aquaculture to the exclusion of large firms is another question. The larger enterprises have a much better chance of success and should therefore not be excluded entirely. For this reason, option (3) would appear to be the most feasible. Such an approach would allow the industry to avail of the advantages which large firms can offer while at the same time protecting the legitimate interests of local people.

Summary and Conclusions

Ireland is a comparative latecomer to the aquaculture field; little interest was shown in the industry prior to the 1970s. The last five years have changed all this. There are currently 40 commercial or semi-commercial operations in existence with at least twenty others at various stages of pilot development. However, a survey of the industry to date shows that only freshwater trout and "on the bottom" cultivation of mussels and oysters have achieved commercial viability. We lack sufficient information on costs and returns to form any definite ideas about the chances of success of the other species. Much further research and development is therefore needed before we can make any definitive pronouncements, but in view of developments elsewhere, the prospects are not unattractive.

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