
**Evaluation of the MAFF
Aquaculture
Research Programme**

Final Report

A report prepared by
Public and Corporate Economic
Consultants (PACEC)
for the Ministry of Agriculture, Fisheries
and Food (MAFF)

Public and Corporate Economic
Consultants (PACEC)
49-53 Regent Street
Cambridge CB2 1AB

Tel: ++44 (0)1223 311649
Fax: ++44 (0)1223 362913
eMail: admin@pacec.co.uk
Web: <http://www.pacec.co.uk>

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EXECUTIVE SUMMARY

1 Introduction

1.1 Between 1990 and the time it was evaluated (early 2001), MAFF's Aquaculture Research Programme supported 39 research projects at a cost of approximately £8 million. The majority of the projects were concerned with topics in the area of fin-fish and molluscan production and cultivation, but the Programme also supported research in the areas of crustacean production, fish and shellfish disease, and veterinary medicines in aquaculture.

1.2 The Programme is ongoing and its objectives are to:

- support a structured programme of research intended to assist the development of a viable and sustainable aquaculture industry in the UK, whilst at the same time protecting the environment
- remove the technical constraints to the industry's diversification into the farming of new marine species
- develop sustainable methods to reduce economic losses from non-notifiable diseases.

1.3 The aims of the evaluation were to:

- test the validity of the rationale for the Programme and assess the appropriateness of its aims
- examine the operation at project level, including the type of projects, success and failure
- examine the operational and administrative effectiveness of the Programme as a whole and at individual project level
- identify lessons for / make recommendations on the rationale, impacts and future management
- assess the outputs and impacts e.g. evidence of scientific advances, technology transfer, quality of scheme and benefits.

It was based mainly on a set of surveys designed to gather feedback and data from the leaders of projects in the Programme, the users of project outputs and other identifiable beneficiaries, proposers of projects that were not supported, and 'stakeholder' organisations (i.e. not directly involved in the Programme, but likely to have an interest in its outputs and outcomes).

2 The findings and conclusions

Is the rationale for the Programme valid?

1. The evidence presented in the report provides a firm basis for concluding that the overarching rationale for the Programme is valid. The Programme

addresses a range of needs and, consequently, different aspects of it have different justifications and rationale statements. However, it is believed that, where the Programme is based on a desire to tackle market failures, this could be made more explicit.

Are the aims and objectives of the Programme appropriate to the rationale?

2. Drawing on the feedback and opinions of stakeholders, it is apparent that the specified aims and objectives are widely considered to fit the rationale. The Programme's rationale is not premised on near-market issues and, correspondingly, the Programme's aims and objectives are considered appropriate to the circumstances of the aquaculture industry. To the degree that there is any dissent, this stemmed from a concern about the lack of explicit prioritisation and how, therefore, the aims and objectives translated in practice. It is also believed that, once they can be defined, consumer interests should be reflected in the aims and objectives.

What has the impact been on the capabilities of the participating organisations?

3. The Programme has delivered mainly moderate impacts on the capabilities and activities of the research organisations. However, technical understanding and capabilities seem to have been substantially enhanced.

What scientific and technological advances have been made, and are they additional?

4. Contract leaders involved in the Programme consider the advances associated with their projects to have been substantial to date. Almost all the recorded effects are additional, as it was found that deadweight and substitution effects associated with the projects were very small.

Has the Programme delivered a range of outputs for dissemination?

5. Outputs arising from the Programme have taken a range of forms, though they have been concentrated in knowledge-based forms, chiefly articles and reports. However, the number of publications per project has been relatively low.

Has the Programme been successful in delivering technology transfer?

6. A considerable amount of technology transfer has been associated with projects supported under the Programme. Much of this has been informal, i.e. in the form of flows of information between research organisations, partner and non-partner organisations.

Have the scientific and non-scientific objectives of the projects supported by the Programme been met?

7. The majority of contract leaders considered their projects to be largely successful in terms of achieving their specified objectives, both scientific and non-scientific. The evidence of external parties tended to endorse the view that the scientific quality of projects in the Programme had been, at minimum, satisfactory.

What are the likely future public effects and private benefits?

8. The future benefits are likely to take the form of further research, and technological and scientific advances. Progress towards commercialisation has been limited to date and does not appear to be a priority for the majority the contract leaders. However, this is largely to be expected given that the Programme is not designed to support near-market research.

What have been the wider effects of the Programme?

9. The Programme has given rise to a number of spin-offs and wider effects, scientific, commercial and environmental. Additionally, some valued links have been established between research and commercial organisations, although the number of wider beneficiaries identified during the course of the evaluation was rather small.

How effective is the management and administration of the Programme?

10. The consensus of participants in the projects is that the Programme is effectively managed and administered on an operational level. The Programme was subject to some criticism from stakeholders (albeit largely based on a partial knowledge of its workings) from which it is inferred that the Programme review process might be made more transparent.

What are the lessons for a future Aquaculture Research Programme?

11. At a strategic level, some conflicting views co-exist surrounding the direction which future aquaculture research should take; broadly, whether the emphasis should be on addressing long-term strategic issues, or on those of more immediate concern to the industry. It is difficult to see how these might be accommodated in one programme.

3 Recommendations

- 3.1 On the basis of the findings, the report makes five recommendations. These can be summarised as:

1. It is important that a Programme of this kind, i.e. one which provides support for research intermediate between pure science and pre-competitive research, should continue.
2. The current Programme should be fine-tuned, rather than being radically overhauled.
3. The Programme's rationale statements should be revised to ensure that market failures which necessitate and justify intervention are explicitly recognised.
4. Proposals for funding under the Programme should make clear who the intended research output users are and how the outputs will be disseminated.
5. The aquaculture industry should be more closely involved when the Programme and its priorities are reviewed.

1. INTRODUCTION

1.1. The MAFF Aquaculture Research Programme

1.1.1. Aquaculture is a relatively young industry and some sectors are at an early stage of development, although others are already commercially successful. UK aquaculture is dominated by the Scottish salmon farming industry, which has grown rapidly over the last 20 years and provides a valuable contribution to the Scottish economy. The smaller trout farming and shellfish cultivation industries are concentrated in England and Wales. MAFF's¹ Aquaculture R&D policy has been aimed at developing the industry as a successful component of the UK economy and, at the same time, at protecting the environment. This has included identifying and exploring the potential for diversification into the farming of new marine species, such as halibut, turbot and scallops.

1.1.2. The rationale for the Aquaculture Research Programme as a whole is, in summary, that the scope to exploit wild fish stocks is limited, and aquaculture is seen as a means of supplementing supply. At present, a limited number of fish and shellfish species are cultivated. Research is needed to help develop the industry to its full potential, including diversification into new species. The small scale nature of the industry makes it difficult for individual firms to bear the risks and uncertainty of funding significant R&D to address the technical constraints that could improve the industry's competitiveness.

1.1.3. In the light of this rationale, the particular objectives of the Aquaculture Research Programme are to:

- support a structured programme of research intended to assist the development of a viable and sustainable aquaculture industry in the UK, whilst at the same time protecting the environment
- to remove the technical constraints to the industry's diversification into the farming of new marine species
- to develop sustainable methods to reduce economic losses from non-notifiable diseases.

¹ MAFF is now part of the Department for the Environment, Food and Rural Affairs (DEFRA), but this report refers to MAFF throughout, since the work on the evaluation pre-dated the change.

1.1.4. MAFF's Aquaculture Research Programme is ongoing, but it supported a total of 39 projects between the period 1990-2001. The projects are spread over 7 thematic areas, with a total value of £8 million. The distribution of projects supported by the Programme by theme is shown in Table 1.1. A full summary of project titles, costs and timescales is given in Appendix A.

Table 1.1 Profile of Projects in the MAFF Aquaculture Research Programme

Theme & Sample Project	No. of Projects	Cost Range, £'000s
FC01 Marine Finfish Production <i>e.g. FC0108 Further studies on the digestive physiology of Dover Sole 1994-7</i>	5	2.2 - 515.4
FC02 Molluscan Production <i>e.g. FC0212 Scallop seabed cultivation development 1995-6</i>	7	3.0 - 753.5
FC03 Crustacean Production <i>e.g. FC0303 Lobster stock enhancement experiment 1990-6</i>	3	40.0 - 286.7
FC04 Fish Disease <i>e.g. FC0421 Studies of proliferative kidney disease 1994-6</i>	2	28.2 - 128.2
FC06 Medicines/Advice to VMD <i>FC0604 Studies on veterinary medicines used in fish farming 1993-8</i>	1	1,069.6
FC09/10 Fish Farming & Shellfish Cultivation <i>e.g. FC0911 Optimisation of formulated diet for marine fish larvae 1998-2001</i>	13	26.0 - 553.3
FC11 Fish & Shellfish Health <i>e.g. FC1125 Factors affecting the disease susceptibility of farmed fish 1998-2003</i>	8	27.8 - 903.3

1.2. Aims and objectives of the evaluation

1.2.1. The aims of the evaluation were to:

- Test the validity of the rationale for the Programme and assess the appropriateness of its aims
- Examine the operation at project level, including the type of projects, success and failure
- Examine the operational and administrative effectiveness of the Programme as a whole and at individual project level
- Identify lessons for / make recommendations on the rationale, impacts and future management
- Assess the outputs and impacts e.g. evidence of scientific advances, technology transfer, quality of scheme and benefits.

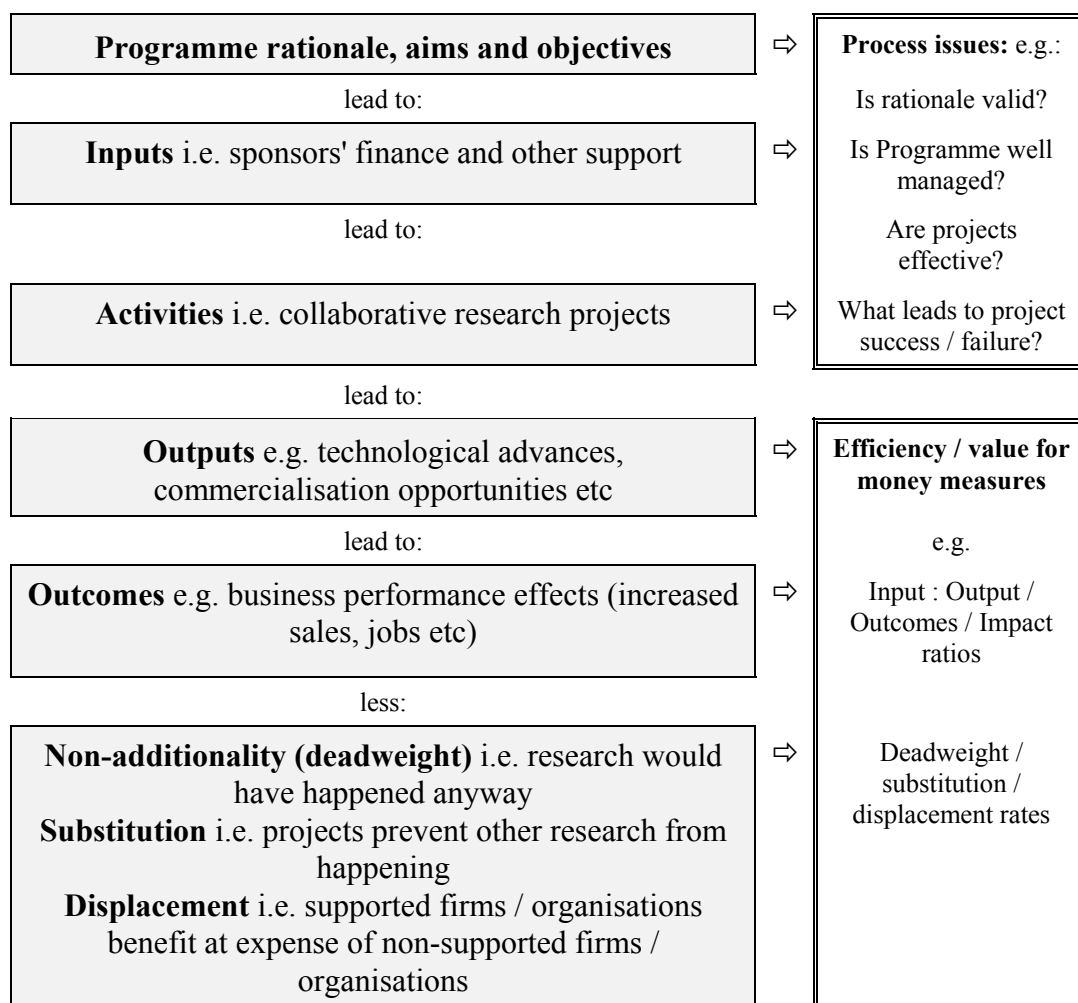
1.2.2. The evaluation sought to assess how effectively the funds have been spent in the past, what has been achieved, and how the outputs can help inform decisions about future programmes. An additional, and informal, objective of the evaluation was to compare, where appropriate, the findings with those from the earlier evaluation, also by PACEC, of the Aquaculture LINK Programme².

1.3. The evaluation framework

1.3.1. The evaluation framework used was one which conforms with HM Treasury's 'Green Book' guidance on appraisal and evaluation; and one which permits processes to be examined and outputs, outcomes and impacts to be measured. The framework, which is illustrated in Figure 1.1, posits that there is a chain of causation which links Programme *rationale, aims and objectives* to *inputs* (i.e. finance and other support), which lead in turn to *activities* (i.e. projects), *outputs* (e.g. technological advances) and *outcomes* (e.g. business performance effects).

1.3.2. The framework also allows for the possibility that some of the outcomes might be *deadweight* (i.e. some of the effects might have been secured in the absence of support from the Programme because the research would have been undertaken anyway), that some *substitute for* others (e.g. where involvement in MAFF Aquaculture Research projects prevented other research from being undertaken), or *displace* yet others (e.g. where supported businesses and organisations secured benefits at the expense of non-supported businesses and organisations).

² PACEC (2000), Evaluation of the Aquaculture LINK Programme, MAFF

Figure 1.1: Aquaculture LINK Programme Evaluation Framework

1.4. Methodology

1.4.1. In order to obtain the information required for the evaluation framework, and to address the evaluation aims more generally, a number of key research tasks were performed. They comprised:

- (a) An initial survey of contract leaders
- (b) In-depth interviews with leaders in selected projects
- (c) A survey of potential wider beneficiaries of the projects / Project partners
- (d) A survey of projects that were not implemented
- (e) A survey of wider stakeholders in the Programme
- (f) Desk-based examination of project annual reports and end-of-project reports.

- 1.4.2. The initial survey of contract leaders (or other leading researchers on the project or co-project officers, where the designated contract leader was not the best placed individual to provide the information sought) were conducted by telephone or face to face, where opportunities presented themselves. The questionnaire for this survey is outlined, alongside the other questionnaires used for the evaluation, in Appendix B to this report, but, in summary, it was designed to collect information on:
- Characteristics of the participants
 - Reasons for participation
 - Costs of participation
 - Impacts on activities and technical capabilities
 - The counterfactual (impacts of participation on other projects: displacement and deadweight)
 - Commercial and economic impacts
 - Wider effects
 - Assessment of the management and administration of the Programme
- 1.4.3. The in-depth interviews with leaders in selected projects were conducted face to face, and they covered broadly the same ground as the telephone surveys. However, the issues listed above were examined in greater depth, with the interviewees being asked to explain and justify, where appropriate, their answers to particular questions.
- 1.4.4. The survey of project partners and potential wider beneficiaries of the projects was conducted by telephone and was designed to explore the extent to which individuals and organisations, not all of whom were directly involved in the Aquaculture Research Programme, had been able to benefit from using outputs and outcomes from projects. A sampling frame was constructed from the information supplied by contract leaders, where they had collaborated with an industrial or research partner, or had liaised with aquaculture businesses or organisations.
- 1.4.5. The survey of projects that were not implemented was also conducted by telephone and was based on a sample of individuals who had submitted either outline or full proposals for Aquaculture Research projects, but who were not granted funding, either because their proposals lapsed or were withdrawn, or

because their proposals were rejected. The survey was designed mainly to discover whether these projects were eventually undertaken anyway, in order to assist the assessment of the additionality of projects that did receive funding. It was also designed to examine whether there were any features of the administration and management of the Programme that inhibited successful applications. The survey excluded project proposals that were known to have been diverted into the Aquaculture LINK Programme.

1.4.6. The survey of stakeholders was designed to complement the results of the other surveys and research tasks. Discussions were held with a range of organisations not directly involved in the Programme, representing aquaculture businesses, trade associations and bodies, aquaculture supply businesses, environmental bodies, and government departments with the aim of obtaining views, other than from the project participants themselves, on the following issues:

- The validity of the rationale for the Programme
- The appropriateness of its aims and objectives
- The effectiveness of the management of the Programme
- Aspects of Programme design and delivery contributing to, or inhibiting, project success
- The scientific quality of projects
- Lessons for a possible follow-on Aquaculture Research Programme to be learned from the current Programme and other similar support mechanisms
- Possible action to encourage greater participation by businesses and research organisations.

A list of the organisations surveyed is presented in Appendix C.

1.4.7. The desk-based examination of project annual reports and end-of-project reports was conducted by an aquaculture specialist in the evaluation team. It was undertaken principally to assist with the assessment of the scientific quality of projects within the Programme. However, in examining the various project reports and other documentation, the opportunity was also taken to consider the relevance of projects to the needs of the industry at the time.

1.4.8. Table 1.2 shows the number of interviews or discussions undertaken as part of the various research tasks outlined above.

Table 1.2 Coverage of the information gathering

Survey	No. of interviews / discussions
a Project leaders	36
b Project partners and wider beneficiaries	25
c Projects not implemented	13
d Programme stakeholders	32

Source: All surveys

1.5. Characteristics of survey respondents and interviewees

- 1.5.1. None of the project leaders interviewed were from industry. Indeed, all but one of them were from research organisations and university departments, and the remaining one was an independent aquaculture expert. The 36 interviews carried out represented a total of 37 projects. In four cases, a single interview was carried out covering two projects, where the second was a direct follow-on from an earlier one. In a small number of cases, where two research organisations had collaborated as research partners, interviews were targeted with a representative from each partner organisation. This amounted to three projects, for each of which two separate interviews were carried out.
- 1.5.2. Almost half of the potential end-users / wider beneficiaries surveyed (i.e. 11 out of 25) were from research organisations or university departments. More than a third (i.e. 10) were from aquaculture or related businesses, and the remainder were representatives of government departments or agencies. The businesses to which respondents belonged tended to be very small, with a mean of 6.6 employees.
- 1.5.3. Amongst the individuals surveyed who had proposed projects that were not implemented, two of the projects originated from businesses, two from trade organisations, four from research organisations and the remaining five from academia. Nine of the projects were proposed in 1994/5, with the remainder evenly spread between 1996-2000.
- 1.5.4. Of the 32 wider beneficiaries surveyed, half came from aquaculture businesses, two from pharmaceutical businesses, three from trade organisations, four from environmental groups, six from government departments or development agencies, and one from a research institute.

1.6. Structure of the report

1.6.1. The structure of this report broadly reflects the structure of the output measurement framework used. Following this introduction, Chapter 2 assesses the rationale and aims of the Aquaculture Research Programme. The report focuses on the level and source of inputs to projects in Chapter 3. The outputs of the Programme to date are examined in Chapter 4. Chapter 5 concentrates on the business and commercial outcomes, while Chapter 6 focuses on the wider effects of the Programme. Chapter 7 considers the management and administration of the Programme and examines the appropriateness of the research strategy to industry. Each of these chapters has its own section drawing conclusions, but Chapter 8 draws overall conclusions and makes recommendations.

1.7. Presentation and interpretation of data

1.7.1. Although the samples sizes in the various surveys that formed part of the evaluation fieldwork were relatively small, for the sake of consistency and ease of interpretation, all the tables in this report show percentages of respondents, except where numbers were extremely small, and it is stated clearly to the contrary. It should also be explained that not all of the questions in the surveys applied to all of the respondents, and that not all of the respondents were able to answer all of the questions put to them. The percentages shown relate to those answering particular questions, rather than to all interviewees in the samples.

1.7.2. Bearing in mind the objective of comparing the results of this evaluation with those from the evaluation of the Aquaculture LINK Programme, the report also highlights key differences in the findings as between the two evaluations.

2. RATIONALE, AIMS AND OBJECTIVES OF THE PROGRAMME

2.1. Introduction

2.1.1. The principal purpose of this chapter is to address the first of the evaluation aims shown in paragraph 1.2.1, ie, to test the validity of the rationale for the MAFF Aquaculture Research Programme and assess the appropriateness of its

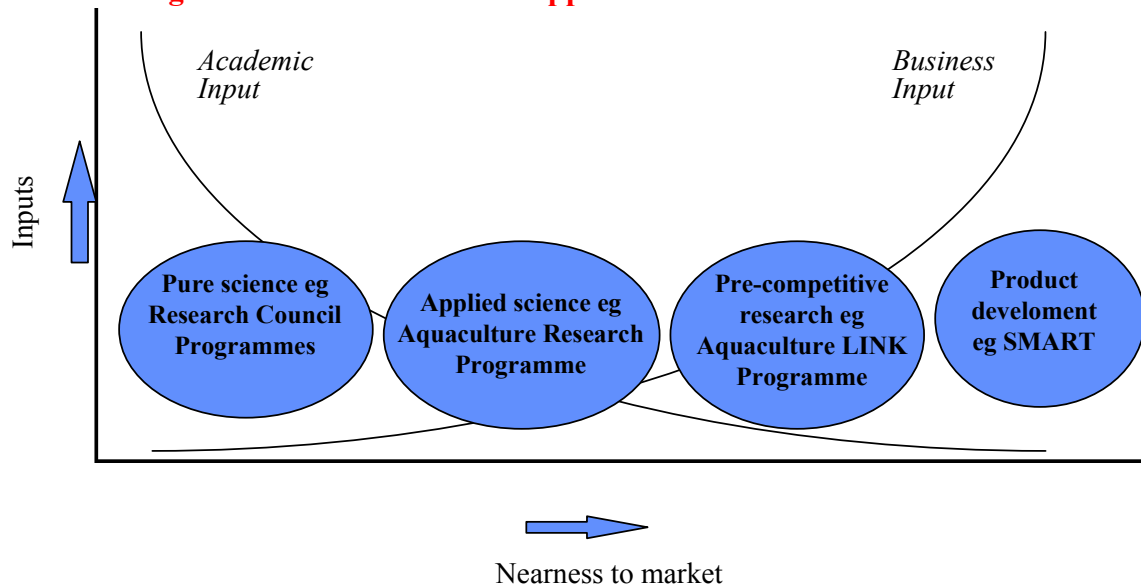
aims. This is achieved partly by reference to the findings of the survey of stakeholders in the Programme, and partly by interpretation of the information supplied by the contract leaders interviewed. First, however, the Programme is shown in its broader context, since this will assist with the examination of its rationale and with the interpretation of the evaluation findings more generally.

2.2. The Aquaculture Research Programme in context

2.2.1. Figure 2.1 represents government support for innovation as comprising a series of interventions during the transformation of knowledge into products that are taken into the market place. It is emphasised that, for ease of exposition, the diagram greatly simplifies the knowledge transformation process, and that it is not intended to catalogue all types of interventions.

2.2.2. The diagram indicates that the government intervenes to support innovation at each of four key stages: when new knowledge is being generated through pure science; when science is being applied to practical problems; when pre-competitive research is being undertaken to make knowledge more commercially exploitable, and; when products, processes and services are being developed for market launch. It also shows typical policy instruments associated with each stage of intervention. In addition, it indicates that academic inputs into the process are initially very high, but decline almost to zero at the threshold of the market. Correspondingly, business inputs are initially very low, but they increase very rapidly as market launch approaches. At each end of the process one type of input tends to dwarf the other, but there is more of a balance between academic and business inputs in the middle stages.

2.2.3. As can be seen from the diagram, the Aquaculture Research Programme is a typical applied science intervention, which is relatively far-from-market. At this stage, academic inputs still dominate business inputs; and the knowledge outputs need to be subject to pre-competitive research (such as in LINK) and product development (such as in SMART or, indeed, without public sector support) before they can be commercially exploited.

Figure 2.1 Government Support for Innovation

- 2.2.4. One implication of the analysis above is that, in light of its place in the spectrum of government support for innovation, the Aquaculture Research Programme would *a priori* be expected to give rise to ideas and opportunities for pre-competitive research, rather than immediately exploitable commercial outputs. Later chapters in this report will indicate the extent to which this holds true. Another implication is that the knowledge upon which the Programme focuses is likely to be still too recondite for the business sector to evaluate and is, therefore, unlikely to attract private sector investment. The extent to which concerns about barriers to investment of this sort underpin the Programme is discussed in the next section.

2.3. Summary of rationale statements

- 2.3.1. As was shown in paragraph 1.1.2, there is an overarching rationale for the Aquaculture Research Programme. In addition to this, each of the research themes within the Programme (see Table 1.1) has its own, more specific, rationale, reflecting the fact that different research themes were intended to address different issues or problems. The individual theme rationales are included in Appendix D, but they can be summarised as follows:
- Promising new species (e.g. halibut, turbot and cod) having been identified, research is needed to establish their full potential and the scope for the diversification and development of the industry. There is no established industry in this sector as yet to undertake the required R&D.

- Potential exists to reduce the pressure on wild stocks through investigation of new methods of production and rearing, and investigating new candidates for cultivation, including non-native species, particularly in the case of shellfish. This is a sector of the aquaculture industry populated by small-scale businesses, with insufficient critical mass to bear the risks and uncertainty of R&D.
- Fish disease is a major constraint to the development of the aquaculture industry, impacting negatively upon fish/shellfish producers and the environment. Improved methods of dealing with fish disease can reduce costs and disruptions, and assist in creating conditions in which the UK industry can flourish. However, the size of the industry limits its ability to attract private investment in R&D, e.g., from major pharmaceuticals businesses.
- There is a requirement for research for the Ministry to fulfil its regulatory responsibilities, e.g. monitoring non-indigenous species introductions, controlling the spread of disease/pests, thereby minimising disruption and extra costs to the market
- Research is needed to enable the Ministry to provide advice on the residues of chemicals used to treat fish and to investigate the possible effects of drugs on the environment.

2.3.2. Collectively, the rationale statements refer, explicitly and implicitly, to three main types of justification for the Programme and its individual themes:

1. a strategic interest in supporting infant industries;
2. a desire to address market failures, principally related to risk and uncertainty, and;
3. the need to fulfil advisory and regulatory responsibilities.

The robustness of these justifications is commented upon in the concluding section of this chapter, and attention now turns to stakeholders' views on the validity of the rationale and the appropriateness of the Programme's aims and objectives.

2.4. Stakeholders' views on the validity of the Programme's rationale

2.4.1. There was a great degree of unanimity amongst the stakeholders interviewed about the continuing validity of the Programme's rationale. All those who expressed a view were broadly supportive, and there was particular agreement that a programme of research is needed to support the diversification of the industry into the farming of new species. Although it is not explicitly stated in the rationale, some conceptualised the need for diversification in terms of

maintaining competitiveness, emphasising that the UK depends on a comparatively narrow aquacultural base, ie salmon and trout, compared to much of Europe. The shellfish industry was identified as an area where public funding of research was particularly justified to assist development of the sector, given that it is populated by small businesses and faces considerable technical constraints. Similarly, the case for assisting research into the farming of marine finfish was regarded as sound and pressing.

2.4.2. There was broad consensus surrounding the appropriateness of supporting emerging sectors of the aquaculture industry amongst those who expressed an opinion. It was recognised that there exists a number of barriers to private investment which underpinned the need for public funding. These included the fragmented nature and relative youth of much of the UK aquaculture industry, and the fact that much research is too costly or uncertain to be borne by individual companies. Others expressed the view that industry is not responsive enough to support fundamental research needed to establish viability of farming new or lower value species, or that some segments are under too great pressure (eg as a result of losses through disease) to divert resources to R&D.

2.4.3. An environmental angle to the need for diversification was recognised, as well as a commercial one, albeit to a lesser extent. This centred on recognition that the scarcity of wild stocks is becoming ever more acute, whilst it was argued by others that over-reliance on two farmed species was potentially environmentally unsound.

2.4.4. A minority expressed the caveat that whilst the rationale for the Programme remained valid overall, more clarification is needed to address the different aquacultural bases and, therefore, needs of England, Scotland and Wales.

2.5. Stakeholders' views on the appropriateness of the Programme Aims and Objectives

2.5.1. The aims and objectives of the Aquaculture Research Programme were seen by the large majority to fit the rationale. Some ranking was distinguishable between the three objectives (Chapter 1, paragraph 1.1.2). The objective relating to sustainability was seen to be particularly desirable amongst

stakeholders in relation to the need to develop the farming of new species and the need to protect the environment. There was substantial support for projects geared towards removing technical constraints to diversification, for example developing halibut and shellfish industry. Endorsed, but to a lesser degree, was the objective related to disease control. Whilst some respondents (typically those involved in the freshwater fish industry) emphasised the appropriateness of this, a small minority said that they did not understand why non-notifiable disease was a particular priority for the Programme.

- 2.5.2. Amongst some, the view emerged that clearer prioritisation of the Programme's aims is necessary. Some raised the issue of achieving the correct balance in terms of spend per sector and likely return. The relatively small amount spent on marine finfish sector vis a vis shellfish was cited in this context. A small proportion of the stakeholders interviewed expressed concern that the projects supported by the Programme did not always reflect the stated objectives, whilst a minority criticised the Programme's objectives for being politically oriented, rather than based on the needs of the industry.

2.6. Contract Leaders' objectives in participating

- 2.6.1. The contract leaders of the projects supported by the Programme were asked about their organisations' objectives (other than scientific objectives) and their responses are summarised in Table 2.1. Nearly three-quarters of the contract leaders specified non-scientific objectives in undertaking their projects. The dominant objective to emerge, for a quarter of those interviewed, related to process improvements, which included the enhancement of techniques, both for research purposes and for use by the aquaculture industry. A slightly smaller proportion hoped that the project would give rise to outputs which would assist the development of the industry generally, for example, by increasing understanding of disease resistance or demonstrating the feasibility of a new feeding method. Collectively therefore, the objectives of the contract leaders in participating in the Programme largely corresponded with the specified aims of the Programme: broadly, facilitating technical innovation and advance to support the development of a viable aquaculture industry in the UK.

Table 2.1 Apart from scientific objectives, what objectives did your organisation want to achieve by undertaking the project? (% replying as shown)

Process improvement	27
No non-scientific objectives	27
Assist development of industry	24
Product improvement	11
New product development	9
New process development	9
Provide baseline data (to government/industry)	9
Develop technology for wider application	9
Demonstrate feasibility of process/method/technology	9
Improved ability to work with industry or other research organisations	6
Publications	6
Increase share of existing markets	3
New market penetration	3
Improved ability to carry out commercially-focused research	3
Obtain finance	3

Source: PACEC survey of contract leaders

2.7. Barriers to achievement of objectives

2.7.1. Contract leaders were asked why it was necessary to obtain MAFF funding in order to pursue the objectives they had specified and their responses are shown in Table 2.2. Whilst a wide range of reasons were cited, these predominantly centred on the perception that it was unfeasible for industry to provide an alternative source of funding. In over half of cases, this was due to financial barriers, namely the lack of cash available from industry for R&D, or lack of incentive, particularly where the project did not expect a readily commercialisable result. Others pointed to the fragmented nature of the industry segment concerned, or the issue of commercial confidence (particularly amongst pharmaceutical companies), both of which acted as barriers to collaboration. It appears, therefore, that the obstacles cited by the contract leaders largely conform with the concerns that underpin the Programme's rationale.

Table 2.2 Why was is necessary for your organisation to obtain MAFF funding to enable you to undertake the project? (% replying as shown)

Aquaculture industry lacks resources/too small	48
Project too far from market	30
Project in direct support of MAFF policy	21
Ineligible for other sources of funding	12
Commercial barriers prevented industry support	12
Research aims too broad/applied to attract other sources	12
Industry too fragmented	9
MAFF funded previous work	9

Source: PACEC survey of contract leaders

2.7.2. The majority of contract leaders had not investigated any alternative sources of funding. Amongst the five who had unsuccessfully sought funding from other bodies, two of these had applied for EU funding, two for funding direct from the industry and one for LINK funding.

2.8. Conclusions

2.8.1. Considering the evidence in this chapter, it appears that, although there are other justifications, the key justification for Government-supported research in the aquaculture industry is the existence of market failure. In the absence of such support, there are considerable constraints faced by the aquaculture industry in terms of risks and uncertainties, which hinder the unsupported emergence of new segments of the industry and the expansion of existing segments. The rationale for the Programme is, therefore, adjudged to be valid, especially in light of the stage in the knowledge transformation process at which the Programme intervenes.

2.8.2. This contrasts with the rationale for the Aquaculture LINK Programme, which its evaluation concluded was inappropriately expressed in terms of a strategic interest in supporting the developing of an infant industry, rather than on an explicit desire to address market failures.

2.8.3. Although it did not emerge as an issue in the surveys of contract leaders, project outputs users / wider beneficiaries and stakeholders, MAFF staff themselves observed that the needs and interests of consumers are not

reflected in the aims and objectives of the Aquaculture Research Programme. Given that it is designed to support far-from-market research, it is not immediately apparent how these needs and interests relate to the Programme, or how they can be accommodated. However, it is clearly desirable that any future Programme reviews should take account of consumer concerns.

3. INPUTS INTO THE PROJECTS

3.1. Introduction

3.1.1. The most visible input from sponsors of the Aquaculture Research Programme into projects is financial, although other important inputs such as advice on project proposal development and project steering, are also provided. Financial support can be, and often is, as great as 100% of the project's cash costs. This chapter examines MAFF's financial inputs, and also the in-kind inputs received from partners and other organisations.

3.2. Level of support from MAFF

3.2.1. The information supplied by the MAFF shows that the average financial input (i.e. grant) was £214,000 per project. Individual projects ranged widely in scale, from £2,200 to £1,070,000. This equates to a total of £8,345,159, covering 39 projects. In all cases, MAFF was the main sponsor, and in the large majority of cases, the only financial sponsor. By comparison, projects in the Aquaculture LINK Programme received, on average, just under £130,000 from one of two sponsors (MAFF and NERC), although, because LINK is a matching-funds mechanism, the average cash value of projects in the two Programmes was similar.

3.2.2. Contract leaders were asked whether the level of funding they had received from MAFF was less than the amount they had sought on application; and, if so, what effect this had had on the scope and scale of the project. Table 3.1 indicates that virtually all the projects received the level of funding sought. Recorded effects such as delays, or reduced scale due to inadequacies in financial support, were, therefore, extremely minor, taking the Programme as a whole. Two project leaders were obliged to reduce the scale of their projects accordingly, of which one also suffered a delay start, whilst a third contract leader reported no significant impact as a result of reduced funding.

Table 3.1 Was the level of funding you received from MAFF less than you sought on application? % of contract leaders

No	92
Yes	8

Source: PACEC survey of contract leaders

3.3. Project Partners' & Contractors' inputs

3.3.1. Contract leaders were asked to provide details of other individuals or organisations directly involved in their projects, and the large majority (73%) identified at least one such organisation. In some cases, the partner identified was a sub-contractor or external consultant, as distinct from those whose input was on a collaborative or voluntary basis. It is, therefore, important to bear in mind that the term 'partner' is used here to denote a range of models of co-operation. The distribution of partnering organisations by sector was slightly weighted towards academic and research organisations, as Table 3.2 demonstrates. However, the aquaculture industry was represented to a significant degree, with aquaculture businesses and trade organisations together accounting in total for 43% of collaborative activity.

Table 3.2 Partnering organisations by type, as % of contract leaders mentioning partners

Publicly funded research organisation	28
Trade association/organisation	24
University department	22
Aquaculture business or supplier	19
Other	7

Source: PACEC survey of contract leaders

3.3.2. Only four projects attracted financial support in addition to that provided by MAFF. In two of these cases the additional finance was provided by a trade organisation or association, in one case the co-funder was a research council, and in the fourth the co-funder was the Crown Estates. In all but one case, the co-funder contributed a small proportion of the total project budget.

3.3.3. Despite the widespread input of external organisations into the projects, it is important to note that most partners' and contractors' inputs were restricted in

scope and scale. Where a partnering organisation was identified, it was possible to distinguish between those whose contribution was on a more-or-less informal basis (for example, providing information, acting in an *ad hoc* advisory role, providing samples) and those who undertook to conduct part of the research, provide specific expertise, or act as project consultant. Technical expertise and know-how were sought to complement the researchers' own, and industry inputs tended to be small in terms of financial value. Few projects were truly collaborative, on the scale of projects supported in the Aquaculture LINK Aquaculture Programme. However, this accords with the rationale for the Programme discussed in Chapter 2. Indeed, collaboration was not a specified objective of the Aquaculture Research Programme, unlike the Aquaculture LINK Programme, in which collaboration formed a key purpose.

3.4. Other inputs

3.4.1. Although the findings demonstrate an almost exclusive reliance on MAFF, at least in terms of providing financial support for the projects, a large proportion of the contract leaders (almost 70%) reported in-kind contributions from other organisations, including their own. As Table 3.3 shows, the source of these resources was predominantly commercial organisations, such as fisheries, farms and hatcheries. University and research organisations accounted for almost a fifth of in-kind inputs, and in most cases, the contract leaders were itemising resources received from their own or partnering institutions (typically laboratory time, personnel time and consumables). However, it is difficult to quantify such inputs, because they were frequently intangible, uncoded and consumed internally.

Table 3.3 Sources of in-kind inputs, as % of contract leaders mentioning receipt of in-kind inputs

Fishery/farm/hatchery	64
University/research organisation	18
Industry organisation/trade association	9
Feed manufacturer	9
Other	9

Source: PACEC survey of contract leaders

- 3.4.2. The mix of in-kind inputs into the projects is shown in Table 3.4 and is clearly weighted towards the provision of raw materials and supplies, rather than know-how or expertise. In many cases, the latter was provided by the partnering organisations discussed above and tended not to be classed as an in-kind input.

Table 3.4 Types of in-kind inputs, as % of contract leaders mentioning receipt of in-kind inputs

Provision of samples	46
Access to trial sites/laboratories	32
Rearing of live samples	18
Provision of data	14
Provision of feeds	9
Personnel time/expertise	9
Provision of equipment	9
Consumables	5

Source: PACEC survey of contract leaders

3.5. Conclusions

- 3.5.1. What emerges from the survey of contract leaders is that nearly all projects were financially supported to the level requested on application, with the result that negative impacts, such as delays, reductions in scale or project objectives, were negligible. It seems likely that, in many cases, an acceptable and realistic figure was negotiated with the Programme's management prior to the submission of a full proposal, thereby minimising the need for downward-adjustments after an award was made.
- 3.5.2. The findings show very limited co-funding of projects, but this is not surprising, given that the majority of contract leaders had not thought it worthwhile investigating any alternative sources of funding in the first place. Where additional funding had been secured from a commercial source, this came from a well-established segment of the aquaculture industry.
- 3.5.3. Partnering was widespread amongst the participating organisations, but restricted in extent, with partner organisations rarely having a great deal of active involvement in the projects. The research was in most cases steered

and conducted by one organisation, with limited, defined inputs from external bodies, often to complement the researchers' own areas of expertise, or to assist with practicalities. This limited input is reflected by findings from the survey of end-users and wider beneficiaries (see Chapter 6), which found limited involvement in, and uptake of the outputs of, projects.

- 3.5.4. The nature of other inputs was wholly in-kind, in both tangible and intangible forms. Whilst industry contributions played a valuable role in the projects, they were mainly confined to provision of supplies and access to sites, and represented a small part of total costs. Given the evolving status of much of the industry, and the far-from-market nature of many projects, this level of input is unsurprising and conforms with the rationale underpinning the Programme.
- 3.5.5. The profile of inputs into the Aquaculture Research Programme projects differs from that observed in the Aquaculture LINK Programme, as would be expected given their respective designs and purposes. Reflecting the fact that it is a collaborative, matching-funds mechanism, receipts of partners' cash and in-kind inputs were considerably greater and more widespread within the Aquaculture LINK Programme.

4. PROGRAMME OUTPUTS

4.1. Introduction

- 4.1.1. This chapter focuses on how the successful the projects were, or have been to date, in terms of producing outputs. The outputs examined by means of the surveys of partners and the in-depth interviews were the intermediate effects, i.e., the effects of the projects on the organisations' technical capabilities, technological advance, technology transfer, scientific papers and publications, new or improved products or processes, and whether the project had given rise to further research.
- 4.1.2. Although the majority of projects had reached completion at the time of interview, it is worth emphasising that in a significant proportion of cases, some outputs and effects were yet to be realised. A number of contract leaders were still in the process of publishing findings arising from the projects, whilst in a few cases, the projects were still ongoing. Thus whilst this chapter refers mostly to outputs and effects achieved to date, there is an attempt to define and quantify effects likely to be felt in future.

4.2. Effects on activities and technical capabilities

- 4.2.1. It emerged that the projects have had at least some impact on the activities and capabilities of all of the participating research organisations. Table 4.1 summarises the findings, and shows that the modal effect of participation overall was minor-to-moderate. The impact has been strongest in the area of technical understanding, where 58% reported that the project has significantly or substantially enhanced performance, and technical capabilities, with 47% reporting a significant or substantial impact. Least effect was recorded on the organisations' involvement in commercially focused research, with over a third reporting no significant effect. However, on this issue many of the interviewees pointed out that their organisations were already commercially focused in their activities. Impacts on partnering capabilities also tended to be lower than other effects, reflecting the limited degree of collaboration inherent in the Programme.

- 4.2.2. It is also worth noting that the pattern and frequency of effects shown in Table 4.1 are similar to the equivalent findings from the Aquaculture LINK evaluation.

Table 4.1 What effects has participation in the project had on the activities and capabilities of your organisation? % of contract leaders replying as shown

	Minor/Moderate	Significant/Substantial
Improved technical understanding	42	58
Improved technical capabilities	53	47
Improved skills	60	40
Greater ability to work with industry/academia	64	36
Greater understanding of partner organisations	66	34
Increased research activity generally	70	30
Increased commercially focused activity in particular	72	28

Source: PACEC survey of contract leaders

4.3. Technological advances

- 4.3.1. Contract leaders were asked to rate the technological advances made by their projects both to date, and where applicable, expected in the future. As Table 4.2 shows, the technological advances associated with the projects to date are considerable. Half of those interviewed reported that there had been a significant advance. Almost 40% of the contract leaders believed that the research was likely to achieve further progress in the future, and projections of these future technological advances tended to be match those observed to date quite closely.

Table 4.2 How would you rate the technological advance(s) made by your project to date, or expected in the future, if work is still ongoing? (% of contract leaders replying as shown)

	Minor	Moderate	Significant
Technological advance(s)			
....to date	13	38	50
....expected in future	14	29	57

Source: PACEC survey of contract leaders

- 4.3.2. The contract leaders' assessments of the technological advances made by their projects, as summarised in Table 4.2, were generally more positive than the

equivalent assessments made by project partners in the Aquaculture LINK evaluation. However, this is thought to be explained in part by the fact that fewer LINK projects were finished at the time of evaluation and in part by the fact that projects in the Aquaculture Research Programme are broadly concerned with creating technology, whereas those in the LINK Programme are more concerned with applying technology.

4.4. Technology Transfer

4.4.1. Contract leaders and other research partners interviewed were invited to describe how, if at all, the process of technology transfer had taken place within the project. The majority - over 70% - indicated that this had occurred to some degree, in the form of advice and technical guidance, shared data, skills and expertise. The types of transfer and their distribution are shown in Table 4.3, from which it can be seen that the single most common method of transfer involved the communication of techniques and methodology related to the project and occurred principally, though not exclusively, between partnering organisations. However, overall, technology transfer was interpreted in its broadest sense by the contract leaders, rather than strictly to mean the movement of intellectual property; and it was, thus, used to describe dissemination of information at a more general level to a range of audiences. It is striking then that the process of technology transfer was both wide-reaching and inclusive, occurring not only between partnering organisations but also extending to the wider research community and the aquaculture industry.

Table 4.3 Methods of technology transfer within the programme (% of contract leaders indicating methods shown)

Demonstration/sharing of research techniques	52
Sharing of feedback/data from project with other research organisation(s)	37
Dissemination of findings to industry	37
Sharing of facilities/equipment	7

Source: PACEC survey of contract leaders

4.4.2. The LINK evaluation showed that a larger proportion of project partners surveyed reported that particular types of technology transfer had occurred. However, this is interpreted as reflecting differences in the composition of

project partnerships as between the two Programmes, rather than as a weakness of the Aquaculture Research Programme. It will be recalled from paragraph 3.3.1 that not all projects in the Aquaculture Research Programme involved more than one organisation. LINK projects, on the other hand, comprise, by definition; more than one organisation; and many comprised three, four or more organisations. The scope for informal technology transfer was, therefore, greater in the LINK Programme.

4.5. Other effects of participation on the activities of the organisation

4.5.1. Contract leaders were asked to describe any other significant effects that participation in the project had had on the activities and capabilities of the organisation. Just over 60% identified such effects and their answers are summarised in Table 4.4. It is apparent that the effects of participation in the Programme were perceived to centre on increased specialisation and establishing organisations as centres of excellence. Conspicuously, there was very little reference made to the application or development of project outputs, commercialisation or future collaboration.

Table 4.4 Other effects of participation in the project % of contract leaders replying as shown

Led / will lead to further research in field	38
Built core competence in field	29
Accumulation of transferable knowledge/skills	24
Enhanced specific expertise (eg physiology/diet/animal behaviour)	24
Increased organisation's research reputation	14
Increased focus on practical/applied research	10
Other	10

Source: PACEC survey of contract leaders

4.6. Outputs arising from the projects

4.6.1. Contract leaders were asked to quantify the different types of research outputs arising from the projects and averages are shown in Table 4.5. As might have been expected, given the nature and stage of the Aquaculture Research Programme, outputs tended to be knowledge or information based, rather than exploitable goods, services, or processes. The majority of those interviewed had produced published outputs arising from their projects. Articles in

academic journals formed the largest category of output, reflecting the fundamental, rather than commercial, nature of many of the projects in the programme and perhaps also the publication requirements of those researchers based in universities. Some had been prolific - six had published five or more articles - whilst others had yet to publish anything. In two cases, publication had been hindered by commercial constraints imposed by the projects' industrial partners. Two thirds of the projects had published at least one article in the trade press. Less than a fifth of the projects had given rise to any new or significantly improved devices or equipment, whilst less than a third had resulted in new or improved processes. Other outputs produced included presentations, seminars, workshops, videos and advice or consultancy. Anticipated future outputs were very few or uncertain, since in many cases, they would depend on a further stage of research going ahead. The exception was published papers, where some contract leaders were able to give clear estimates of work in progress or were awaiting publication of written articles.

Table 4.5 How many of the following outputs have there been from your project to date, or how many do you expect in the future? (Mean number of outputs reported by contract leaders)

	To date	Expected
Papers in academic journals	2.1	0.3
Articles in the trade press	1.5	0.1
Other research reports	1.4	0.1
New/significantly improved production processes	0.7	0.0
New/significantly improved devices or equipment	0.5	0.0
Information leaflets	0.3	0.1
New or significantly improved feedstuffs	0.1	0.0
New or significantly improved vaccines	0.0	0.1
Other	1.4	0.1

Source: PACEC survey of contract leaders

- 4.6.2. Rates of publication from Aquaculture Research Programme projects were found to be substantially lower than those achieved by research partners in the Aquaculture LINK Programme, i.e. 3.9 per project in the former compared with 6.8 achieved by the latter. This is regarded as disappointing, especially in light of the fact that a greater proportion of projects in the Aquaculture Research Programme were completed at the time of the evaluation. The difference is partly explained by the greater number of partners in a typical

LINK project, but it is also thought to reflect the fact that two of the main contracting organisations in the Aquaculture Research Programme (i.e. CEFAS and the SFIA) are not particularly publications-oriented.

4.6.3. It might also be noted that LINK projects tended to give rise to more outputs in the form of new or improved products, processes and devices. However, this is entirely as would have been expected, given that LINK projects are nearer-to-market than Aquaculture Research Programme projects.

4.7. Contract leaders' assessment of the projects

4.7.1. Contract leaders were asked to assess the success of their projects in relation to both the scientific and non-scientific objectives they had at the outset (see Table 2.1). Collectively, they were positive in their assessment as Table 4.6 indicates, showing mean ratings on a scale of 1 to 5 where a score of 5 represented "completely successful."

Table 4.6 How would you rate the success of the project in relation to its objectives? (Mean score, where 1=not at all successful and 5=completely successful)

Scientific objectives	4.2
..Non-scientific objectives	4.0

Source: PACEC survey of contract leaders

4.7.2. Projects were considered to be slightly more successful in meeting their scientific objectives than non-scientific objectives. Amongst the projects rated highly successful, the explanations given by the researchers were principally that the project had achieved what it set out to do, that they had made technological or methodological advances, or increased their understanding of, for example, an organism or pathogen. Some located the success of the project in the delivery of data or tools to the aquaculture industry, or the fact that it had given rise to further research. Amongst contract leaders who rated their project as low to moderately successful, the reasons given were chiefly that the objectives had only been partially met, hypotheses not entirely supported, or that technical difficulties had hampered progress.

- 4.7.3. As the Table shows, amongst the contract leaders who also had non-scientific objectives in undertaking the research (i.e. around 70%), the mean rating of projects was 4.0. Whilst this score was slightly lower than the scientific rating, a large proportion of leaders were keen to emphasise that it was too early for commercial or non-scientific benefits to emerge, or that these would be dependent upon the project's success in meeting its scientific objectives. Projects were adjudged to have been successful if their findings were being applied commercially, if they had increased the industry knowledge-base, or where they had or were expected to result in improved products or further research. Some regarded publication or dissemination of findings as a measure of success.
- 4.7.4. Contract leaders and research partners were asked whether they had or planned to undertake any further research arising from the project. As Table 4.7 indicates, more than half of the contract leaders had already proceeded to a further stage of research, and this proportion rises to over 70% when those planning to take pursue this path are included. Less than a third stated that they had neither undertaken, nor intended to undertake, any follow-on research. In a minority of cases, this was due to the discontinuation of MAFF funding in the respondent's research area or to staff redundancy.

Table 4.7 Has your organisation undertaken any further research arising from this project? (% of contract leaders)

Yes	57
No, but plan to	14
No	29

Source: PACEC survey of contract leaders

- 4.7.5. Where follow-on projects had taken place, or were planned, these had been funded (or were likely to be funded) by a range of sources, with half reporting a contribution from the MAFF Aquaculture Research Programme, or from industry. A large proportion had been supported under the Aquaculture LINK programme, which requires matched support, in cash and kind, from industry. This shift towards commercial funding sources reflects that many projects were expected to be nearer-market at this subsequent stage. However, the main source of funding for follow-on projects remained non-commercial in over 75% of cases, as Table 4.8 indicates.

Table 4.8 How was this further research funded, or how is it likely to be funded? (% of contract leaders who had undertaken, or planned to undertake, further research)

	All sources	Main source
MAFF Aquaculture Research Programme	50	26
Industry/Private Sector	50	11
Aquaculture LINK Programme	41	21
EU Framework Programme	36	26
Research Council	14	5
Other	18	11
Not sure yet	5	-

Source: PACEC survey of contract leaders

4.8. External views on the scientific quality of the Programme

- 4.8.1. The survey of stakeholders sought to address the issue of scientific quality of the projects within the Programme, and it is appropriate to consider the outcome of these discussions here. The majority of the discussions were with individuals who had had no direct involvement in individual projects, and their comments were mostly limited to generalisations about the Programme as a whole.
- 4.8.2. The quality of the Programme was rated highly by half of those interviewed, i.e., most of those who felt able to comment. However, a small, but significant, proportion found the Programme variable in terms of scientific quality. This was not in all cases seen as a shortcoming of the Programme *per se*, but an inherent risk of research in bio/ecosystems. Overall, the consensus was that the quality of projects supported by the Programme was underpinned by sound science, the involvement of highly skilled research staff and an effective review system. A view emerged amongst a minority that a small number of projects in the Programme did not justify funding on the basis that they were unlikely to deliver either scientifically or commercially useful results.
- 4.8.3. Although the stakeholders had limited knowledge of individual projects, the assessments of familiar projects were, without exception, favourable. In

particular, the PKD projects were singled out, as were projects relating to formulated fish diets and shellfish biotoxins, as being particularly strong.

- 4.8.4. Few of the stakeholders felt qualified to offer specific criticisms of the Programme's scientific quality, but some felt that slow progress was a shortcoming (compared to commercially-sponsored research, which would be quicker), as was the failure to place research findings in the public domain, thereby limiting uptake.
- 4.8.5. As part of the evaluation, an aquaculture consultant from MacAlister Elliott and Partners was briefed to review Programme and project files held by MAFF:
- primarily, to examine what steps were taken by MAFF to ensure that the scientific quality of the Programme was safeguarded; and
 - secondarily, to consider whether projects within the Programme were relevant to the needs of the industry at the time.
- 4.8.6. On the subject of safeguards for the scientific quality of the Programme, the review concluded that the quality of science appears to have been more rigorously assessed in those projects where the contractor was other than CEFAS laboratories at Conwy and Weymouth or SFIA Ardtoe. Activities at CEFAS and at the SFIA tended to be monitored by MAFF scientific staff directly in regular meetings, rather than through specific written procedures. However, because these organisations were well known to MAFF, it was reasonable to assume that scientific objectives, once established, would be adhered to. The emphasis was, therefore, one of trying to ensure that the direction of the work was useful to industry or society generally, rather than detailed monitoring of scientific procedure. Overall, monitoring of the quality of science was found to have been satisfactory throughout the period under review.
- 4.8.7. On the secondary issue of the relevance of projects to the needs of the industry at the time, the review found that some of the projects in the early part of the period covered by the evaluation could not be regarded as particularly relevant. However, it acknowledged that much of this 'less relevant' work had ceased to be supported by the Programme. It also found

that a new Programme review process, implemented in 1999 and involving greater consultation with industry interests, was more rigorous than previously and was, therefore, more likely to ensure relevant research is undertaken.

4.9. Conclusions

- 4.9.1. It emerges from this chapter that the Programme has given rise to a range of outputs; and has impacted on the activities and capabilities of all of the research organisations involved, at least to some extent.
- 4.9.2. Whilst the most significant effects have occurred internally, in the form of technological advances which accrue to researchers' own organisations, informal technology transfer associated with the projects has been widespread. This has been mostly in the form of information flows between organisations, and though it is difficult to ascertain whether this has led to uptake of new skills and know-how, or whether for general information purposes, it is encouraging that much of the exchange has occurred with organisations outside the Programme, i.e., non-partners. The issue of the external, or wider, effects of the Programme is returned to in Chapter 6.
- 4.9.3. Very few commercialisable outputs have been produced as a result of projects undertaken, but this is not to be taken as a disappointment, given the Programme's relatively far-from-market position. The Programme appears to have been particularly fertile in terms of giving rise to further research, suggesting that for the majority of projects, there is a process of evolution from fundamental research towards an applied or near-market stage.
- 4.9.4. On the basis of the feedback from the stakeholders surveyed, the scientific quality of projects in the Programme is adjudged to be, at minimum, satisfactory and, more generally, good. The independent review of Programme files also indicated that the measures in place within MAFF to safeguard and monitor scientific quality are satisfactory.

5. PROGRAMME OUTCOMES

5.1. Introduction

5.1.1. Consistent with the chain of causation embedded in the evaluation framework, attention now turns to examining how the project outputs (as reported in the previous chapter) have been translated into outcomes, or business performance effects. This chapter first looks at the progress made towards commercial exploitation of the outputs of projects to date. Then, with reference both to the subjective views of the contract leaders and to the results of the survey of projects that were not supported by the Programme, the issue of additionality is examined.

5.2. Progress towards commercial exploitation of project outputs

5.2.1. Table 5.1 describes the progress made by contract leaders' organisations towards the commercial exploitation of the outputs of their projects. The great majority - four fifths of respondents - had not made any progress towards commercialising the outputs of the project, nor did they plan to. For many, commercialisation was seen as inappropriate or premature given the nature of the research. Some contract leaders were able to identify opportunities for commercialisation, but specified that it was not within the remit of their organisations (i.e. because they were not-for-profit / advisory / publicly-funded research organisations) to develop commercial applications themselves. Others pointed out that their project had been undertaken for strategic reasons or to establish baseline data, and had not been intended to be of immediate benefit to the industry. Overall then, whilst commercialisation by the research organisations themselves has been insignificant, the production of outputs put in the public domain had provided opportunities for commercialisation by other parties.

Table 5.1 Has your organisation commercialised any of the outputs from this project? (% of contract leaders)

Yes	3
No, but plan to	15
No	82

Source: PACEC survey of contract leaders

- 5.2.2. In the few cases where commercialisation of the outputs had begun, or was expected to take place, it was being led by an industrial partner rather than by the research organisation directly. In two cases, the contract leader's organisation had acted or proposed to act as research partner, in one case to feed manufacturers, in the other to a commercial hatchery. In a third case, the interviewee, who worked as an independent aquaculture consultant, planned to work on a PESCA-funded project in conjunction with industry to conduct commercial trials aimed at demonstrating the viability of cultivating a new species. A fourth had acted in an advisory role, providing design and specification advice to commercial hatcheries. In one case, the contract leader and co-project officer described how their agreement with an industrial partner had acted as a constraint to realising the full commercial potential of the project. This was because the industrial partner was concerned only with pursuing narrow commercial interests, whilst the research partners would have preferred to collaborate with a number of partners to develop the full range of opportunities identified but were prevented from doing so.
- 5.2.3. The findings embodied in Table 5.1 contrast with the equivalent findings from the LINK evaluation, which revealed that only 38% of partners surveyed had made no progress in commercialising the outputs of their projects, nor had plans to do so. Again, however, this contrast is largely as might have been expected given the respective positions of the two Programmes in the spectrum of Government support for innovation.

5.3. Business performance effects

- 5.3.1. The contract leaders were asked to quantify or estimate, how their organisations' income and employment had been affected by participating in the project, and to give projections of likely future effects. However, in light of the factors discussed above, very few were willing or able to provide this information, and it is not possible to present meaningfully aggregated data for the business performance effects of the Programme as a whole. The individual responses are, therefore, summarised below and include income and employment effects resulting from further research funding obtained.
- One contract leader reported increased income of £150,000 per annum since 1997 and 2 additional staff. These effects arose as a result of collaborative projects with three aquaculture suppliers to develop feeds commercially.

- Another organisation reported increased income of £50,000 per annum for the years 1996-2000 and one additional member of staff over the same period.
- One organisation had experienced increased income of between £75,000-£100,000 per annum from 1997-2000. This had helped to maintain 2 jobs.
- A further 3 organisations reported small increases in employment (typically, one full-time post) that had been facilitated by a income streams they had been able to attract as a result of their Aquaculture Research work to undertake a further stage of research.

5.3.2. The contract leaders were also asked whether there were any other changes in the organisation's performance that were associated with participating in the project. About a quarter of respondents were able to identify effects, although in some cases, these overlapped with the effects on organisational activities and capabilities described in Chapter 4. Three organisations reported that participation in Aquaculture Research Programme had resulted in greater ease of obtaining funding for subsequent research, in some cases, collaborative projects. Two organisations stated that they had well-established links with other experts in the field, which might prove germane for future collaboration. Two contract leaders described how participation had led to increased specialisation within the researcher's department which had the benefit of raising the organisation's profile in the wider research community.

5.3.3. Business performance effects were associated less frequently with the Aquaculture Research Programme than with the LINK Programme, but this is, again, as would be expected, given the relatively far-from-market position of the former.

5.4. Additionality

5.4.1. Additionality is a measure of the extent to which the outcomes described above are truly attributable to the Programme; and there are two types of non-additionality to consider. The first is deadweight, which measures the extent to which the outcomes arise from projects that would have gone ahead anyway without the support of the Programme. The second is substitution, which measures the extent to which outcomes that arise from projects

supported by the Programme prevented or took the place of other or similar projects.

Deadweight

5.4.2. From Table 5.2 it emerges that only a few of the projects would have gone ahead without the support of the Programme. Amongst the minority that would have gone ahead anyway, the contract leaders thought that the alternative would have been delayed or smaller projects. The deadweight associated with the Programme was therefore extremely small.

Table 5.2 In the absence of support from the MAFF Aquaculture Research Programme, would the project have gone ahead in some form? (% of contract leaders replying as shown)

Not at all	84
Yes, but later	8
Yes, but on a smaller scale	8
Yes, same scale and timing	0

Source: PACEC survey of contract leaders

5.4.3. By way of comparison, the amount of deadweight associated with LINK projects was found to be greater than the amount indicated for Aquaculture Research Programme projects. This is explained by the fact that LINK projects happen closer to the market, generally following-on from applied research work typical of the Aquaculture Research Programme. LINK projects, therefore, proceed on the basis of less risk and uncertainty and are, therefore, more likely to happen anyway.

Substitution

5.4.4. Table 5.3 shows that there was virtually no evidence that the projects supported by the Programme had any negative effects in terms of substituting for or displacing other, similar projects. In the single case where the Aquaculture Research Programme project had prevented other work from going ahead, the project had been designed to compensate for the displaced projects, which would have been regional, smaller and less cohesive than the project in question; and the contract leader was keen to emphasise that the outcome of the substitution was a net increase in research activity. The general absence of substitution was explained by several of the contract leaders who described how their organisation's capacity was fairly flexible in

terms of staffing and, hence, that the funding for the project had allowed the organisation to take on additional staff to carry out the research.

Table 5.3 Did the project entirely prevent, reduce in scale or delay other, similar projects? (% of contract leaders replying as shown)

	Yes	No	Don't Know
Entirely prevented other projects	3	94	3
Reduced in scale other projects	0	97	3
Delayed other projects	0	97	3

Source: PACEC survey of contract leaders

5.5. What happened to projects that were not implemented

- 5.5.1. The survey of projects not implemented under the Programme was designed partly to provide objective evidence on the additionality of the Programme in terms of its outputs and effects. It also explored whether opportunities to produce valuable outputs were missed by the decision not to support the projects. The survey did not include project proposals that were known to have been diverted into the Aquaculture LINK Programme. It was also the intention that the survey should shed light on whether there is anything about the administration of the Programme that contributes to the failure of proposals.
- 5.5.2. The survey included interviews with the proposers of 13 projects that were not implemented. Two of the projects originated from businesses, two from trade organisations, four from research organisations and the remaining five from academia. Nine of the projects were proposed in 1994/5, with the remainder evenly spread between 1996-2000. Given the amount of time that had elapsed since submission of the proposals, it is difficult to be certain exactly how many of the projects reached full proposal stage, and how many were rejected at outline stage. However, it appears that the majority were submitted and rejected as full proposals.
- 5.5.3. The objectives of unsupported projects, (other than scientific objectives), show a different profile from those of supported projects, as Table 5.4 demonstrates. Amongst the former, there was greater emphasis on new

process development and the ability to work with industry or other research organisations. Only 15% stated that there were no non-scientific objectives associated with the proposal, compared to almost a third of the supported project leaders who said the same. This difference may be significant, suggesting that the rejected projects were more applied in orientation and hence considered near-market.

Table 5.4 Objectives of supported and non-supported projects, (% of respondents)

	Supported % (n=36)	Non-supported % (n=13)
Scientific objectives only	29	15
Contribute to development of aquaculture industry	25	23
Process improvement	25	15
New process development	11	31
New product development	11	15
Improved ability to work with industry/other research organisations	7	31
Obtain finance	7	8
Improved ability to carry out commercially focused research	4	15
Publications	4	15
Reduce reliance on antibiotics/pesticides	0	15

Source: PACEC surveys of contract leaders & projects not implemented

5.5.4. Table 5.5 shows that unsupported and supported projects had a little more in common in terms of reasons for seeking MAFF funding to undertake the project, with both groups citing limited industry resources as the primary barrier to alternative funding. Here again though, there is divergence between the unsupported proposers, who were more likely to expect a favourable response from MAFF on the basis of previous funding for similar work (27%) or because the proposed project was believed to coincide with MAFF policy areas or interests (31%). This tendency might suggest that some projects were submitted because they were considered likely candidates for MAFF funding, rather than because they embodied appropriate or achievable scientific objectives. Whilst approaching half of the successful proposers believed their project to be too far-from-market to attract industry funding, this was mentioned by only 15% of the unsuccessful group.

Table 5.5 Why was is necessary for your organisation to seek MAFF funding to enable you to undertake the project? (% of respondents)

	Supported	Unsupported
Aquaculture industry lacks resources/too small	55	31
Project too far from market	41	15
Project in direct support of MAFF policy/had indicated interest	17	31
Industry too fragmented	17	-
Ineligible for other sources of funding	14	23
Commercial barriers prevented industry support	10	-
Research aims too broad/applied to attract other sources	10	-
Related to earlier MAFF- funded phase of research	7	27

Source: PACEC surveys of contract leaders & projects not implemented

5.5.5. As Table 5.6 illustrates, the most common perceptions of why projects were rejected were that they did not conform to MAFF's priorities, or that there was insufficient industry support for the proposed research. However, the proposers were not always able to identify the reasons why they were unsuccessful; and some commented that, as they had received no feedback from the applications process, they were only able to guess at the reasons for MAFF's decision.

Table 5.6 Why, in your view, was your proposal unsuccessful? (No. of unsuccessful proposers)

Don't know	4
Did not conform with sponsors' priorities	3
Competition with other research organisations	2
Industry should support	2
Cost	1
Too speculative	1
Lack of perceived commercial viability	1

Source: PACEC survey of projects not implemented

5.5.6. As the above shows, the proposers tended not to locate the reasons for rejection in the scientific or technical quality of the outlined projects, yet concerns over quality formed the most significant reason for MAFF's decision not to fund the projects. Table 5.7 shows that two fifths were turned down on these grounds. An equal proportion was rejected on the basis that the

proposal did not constitute original research that had not been carried out, or proposed, elsewhere.

Table 5.7 MAFF's reasons for rejection of proposals (N)

Unrealistic proposal/technical problems	5
Overlap with/replication of other research	5
Low priority research	4
MAFF not appropriate customer/resubmit to LINK	3
Cost	2

Source: MAFF project files

- 5.5.7. It was found that of the surveyed projects, in the absence of MAFF funding, only two went ahead anyway, one of which was funded under the LINK scheme. This tends to confirm what the findings from the survey of contract leaders indicated about the additionality of projects (see Table 5.2). (In the sample as a whole, this is believed to increase to 4 out of 16 projects that went ahead, three of them with LINK funding).
- 5.5.8. Of the two projects that went ahead anyway, both research leaders reported some negative impacts, namely, delayed start, and in one case, less ambitious technological objectives.
- 5.5.9. All of those surveyed were asked whether any scientific or commercial advances had been foregone as a result of failing to secure MAFF funding. Of those who were able to offer an opinion, six believed that significant or substantial technological advances had been lost, whilst two thought these had occurred on a modest scale, and two believed there had been no such loss. Amongst those who believed advances had been foregone, six specified that similar technology or techniques had been developed by research organisations abroad - in four cases, in Canada and Norway. It was uncertain however whether these developments had occurred at the same time as the proposed project would have been carried out, or whether they occurred subsequently.
- 5.5.10. Estimates of commercial opportunities foregone tended to be lower. Four proposers did not believe any such loss had occurred, whilst four rated losses as modest, and only two as significant. This modest assessment of lost

commercial potential might reflect the likelihood that these opportunities would not be expected to emerge until a later stage of research. However, these projected losses are relatively high compared with the actual progress towards commercialisation recorded by the 37 supported projects, discussed earlier in this chapter.

5.6. Conclusions

- 5.6.1. Collectively, the progress towards direct commercialisation of the outputs of projects in the Aquaculture Research Programme has been modest to date. However, this is unsurprising, given that most outputs were knowledge and information orientated, and not readily exploitable in the market place. Furthermore this outcome accords with the nature of the Programme, which is intended to support applied, rather than pre-competitive, research.
- 5.6.2. Where opportunities for commercialisation have been identified, in all cases the next steps had been led by an industrial partner, with the contract leader's organisation working in a collaborative, or advisory capacity. Thus, whilst business performance effects may not be substantial, it is encouraging to find evidence that projects progress towards collaboration with industry at the next stage.
- 5.6.3. This chapter has provided strong evidence of the high degree of additionality of projects supported under the Programme. It was reassuring to find that the subjective evidence provided by the contract leaders indicated that there was little deadweight and negligible substitution associated with the projects. The findings from the survey of projects that were not implemented would seem to attest further to the additionality of outcomes and outputs produced by the individual projects and of the Programme as a whole.
- 5.6.4. Compared to projects supported under the Aquaculture LINK Programme, the evidence relating to how the projects have evolved shows some striking differences. Less than a fifth of Aquaculture Research Programme contract leaders had identified commercialisation opportunities, compared with almost half of the research leaders from the LINK programme, and a further fifth who had made formal plans towards exploitation of these opportunities. Nevertheless, the majority of Aquaculture Research Programme contract

leaders had pursued, or were planning to pursue, a further stage of research (in some cases, sponsored under the LINK programme), which may ultimately lead to a pattern of outcomes more akin to those described by the LINK contract leaders.

6. WIDER EFFECTS OF THE PROGRAMME

6.1. Introduction

6.1.1. The previous chapters have examined the direct outputs and outcomes produced by the Programme, focusing mainly on what the effects have been on the research organisations involved. In this chapter, attention turns to the wider effects, including those external to the contract leaders' organisations, in order to make a full assessment of the benefits of the Programme. It will take into account spin-off effects of participation in the projects, benefits to project partners and non-project partners arising from dissemination of the results, and any other positive or negative effects, including social and environmental impacts that are considered attributable to the Programme.

6.2. Spin-off and other external effects of projects

6.2.1. Contract leaders were asked whether any wider and external effects had occurred, and whether such effects were likely to occur in the foreseeable future. Their responses are shown in Table 6.1. For the most part, these reiterate the findings reported in earlier chapters, i.e., that outcomes have predominantly been scientific or knowledge-based, and have largely accrued to the research and academic communities to date, though it is hoped that there will be significant uptake by the aquaculture industry in time. Wider effects external to the research partners' organisations occurred on a smaller scale. Almost a third of contract leaders named environmental benefits as a spin-off from the projects and these took a variety of forms. Half of these referred to improved monitoring capability or the collation of baseline data, for example, on pollution levels, whilst reduced environmental damage and reduced reliance on drug and chemical interventions in fish cultivation accounted for most of the remainder. Animal welfare was named as a potential benefit by 18%, in relation to improved techniques in hatchery rearing, and improved knowledge of animal stress levels. Two contract leaders saw potential for local economic benefits as a result of improved cultivation techniques.

6.2.2. A similar pattern of wider effects was found in the LINK evaluation, but each effect tended to be mentioned more frequently. Again, this is attributed to the

fact that LINK projects involve more mature, i.e. more readily usable, technologies.

Table 6.1 What wider effects, ie other than on your organisation and collaborators in the project, have occurred or are likely to occur in the foreseeable future? (% of contract leaders replying as shown)

Spin-off scientific ideas	36
Strengthening of the skills base within the aquaculture industry	33
Social benefits - environmental	30
Strengthening of the skills base within relevant areas of research in academia	30
Spin-off commercial ideas	27
Improved animal welfare	18
Benefits to suppliers to the aquaculture industry	15
Benefits to retailers/wholesalers	15
Improved teaching capability within academia	15
Other	15
Social benefits - public health & safety	6
Other benefits to companies outside the sector	3

Source: PACEC survey of contract leaders

6.3. Wider effects from dissemination

6.3.1. As the introduction to this report indicated, if the Programme has been fully successful in meeting its aims, it should have had effects and benefits beyond those accruing to the participating research organisations. The survey of end-users and wider beneficiaries addressed the extent to which this was in fact the case. Contract leaders were asked to provide the names of any organisations in the UK or overseas who were believed to have made use of the outputs from the project. Thirty four such organisations were identified, which was some way below the number that the projects had been expected to generate. Of these, twenty five took part in the survey.

6.3.2. In some cases it transpired that the organisation had not in fact made any use of the project outputs beyond referring to them for general information purposes. It is also worth noting that not all of the end-users were located in the UK: two were in France, one in Norway and one in Canada. The distribution of the surveyed organisations by sector is shown in Table 6.2.

Table 6.2 Sector of end-users and wider beneficiaries, (%)

Aquaculture business or supplier	28
Other publicly funded research organisation	28
University department or institute	16
Government department or development agency	16
Trade association/organisation	12

Source: PACEC survey of end-users & wider beneficiaries

- 6.3.3. It is apparent from Table 6.3 that three quarters of the end-user organisations had had some direct involvement in the Aquaculture Research Programme themselves. In the majority of cases, this involvement was in the role of co-sponsor, providing inputs in cash and in-kind, or advice, and in a small minority of cases the end-user was also a project partner. In two cases, the respondents had themselves acted as contract leader on projects in the Programme; and this is what their direct involvement referred to.

Table 6.3 End users' and wider beneficiaries' involvement in the Aquaculture Research Programme (%)

Has had direct involvement	76
No direct involvement	24

Source: PACEC survey of end-users & wider beneficiaries

- 6.3.4. The survey found that written outputs were by far the most widely used outputs from the Programme amongst the end-users. Nearly 90% of those surveyed had used academic papers or other research reports (Table 6.4), whilst approaching half had had recourse to general advice from the project leaders themselves. Unsurprisingly given that few were produced, the use of new or improved products or devices was considerably lower. The 'other' outputs end-users referred to included computer software and working documents or workshops.

Table 6.4 Types of outputs used (% of end users and wider beneficiaries)

Papers in academic journals	88
Other research reports	88
Articles in the trade press	84
Information leaflets	72
General advice/word of mouth	44
New or significantly improved devices or equipment	32
New or significantly improved production processes	28
New or significantly improved drugs/vaccines	12
New or significantly improved feedstuffs	12
Other	16

Source: PACEC survey of end-users & wider beneficiaries

6.3.5. End-users were asked whether use of the Programme's outputs had had any effect on the activities and capabilities of their organisation. The degree of impact reported by the end-users, and shown in Table 6.5, is perhaps surprising. The modal response from end-users fell in the 'significant' category, indicating a higher impact overall than that reported by the contract leaders. A possible explanation is that end-users, particularly those in industry, are inclined to be selective in their uptake of outputs and only make use of those that specifically address an area in which they are already seeking advice or expertise.

Table 6.5 What effects has use of outputs had on the activities and capabilities of your organisation? (% replying as shown)

	None/not significant	Moderate	Significant	Substantial
Increased research activity generally	8	24	52	16
Increased commercially focused activity in particular	28	24	48	-
Improved technical understanding	8	24	56	12
Improved skills	8	32	56	12
Improved technical capabilities	12	20	56	12
Greater understanding of partner organisations	4	36	48	12
Greater ability to work with industry/academia	12	32	44	12

Source: PACEC survey of end-users & wider beneficiaries

- 6.3.6. A range of other effects were identified by the end-users; and these are shown in Table 6.6. As can be seen, these other effects largely tended to cluster around forging better links cross-sectorally, between industry and academia or research organisations. End-users tended to report that as a result they were better informed of research in areas relevant to their organisation.

Table 6.6 Other effects use of outputs has had on activities and capabilities or organisation % replying as shown

	%
Improved networking	24
Closer links with scientific/research base	16
Closer links with industry	12
Improved knowledge of & access to research funding	12
Too early to say	12
Advanced knowledge of aquaculture/management techniques	8
Other	12

Source: PACEC survey of end-users & wider beneficiaries

- 6.3.7. Two thirds of the end-users had, or planned, to undertake a further stage of research following on from project in the Programme (Table 6.7), a proportion which is on a par with the contract leaders' plans to undertake further research.

Table 6.7 Has your organisation undertaken any further research arising from this project? %

Yes	44
No, but plan to	24
No	32

Source: PACEC survey of end-users & wider beneficiaries

- 6.3.8. As Table 6.8 shows, industry and EU funding together accounted for approximately half of the funding of further research planned. Other sources included government departments (other than MAFF), DEMA, overseas sources, and university research grants.

Table 6.8 How was this further research funded, or how is it likely to be funded?

	Main source (n=17)
EU Framework Programme	4
Industry/Private Sector	4
Aquaculture LINK Programme	1
MAFF Aquaculture Research Programme	1
Others	7

Source: PACEC survey of end-users & wider beneficiaries

6.3.9. A small proportion of end-users had so far taken any steps towards commercial exploitation of the project outputs, whilst a slightly larger proportion had identified opportunities that they planned to pursue (Table 6.9). Overall, progress towards commercialisation tended to be more advanced amongst the end-users than the contract leaders themselves, but this is unsurprising, given that there was much greater industry representation amongst the former group.

Table 6.9 Has your organisation made progress towards commercialisation of outputs from the Programme? %

Yes	12
No, but plan to	16
No	72

Source: PACEC survey of end-users & wider beneficiaries

6.3.10. Again, because of the small number of cases for which data relating to income and employment effects of using project outputs were available, it is not possible to present the data in an aggregated form. The effects of commercialisation are, instead, summarised below.

- One organisation, a Norwegian research institute, had scaled up its research capabilities, and attracted an extra £100,000 in funding. This was projected to increase to £750,000 over the next 3 years.
- In three cases, all industry associations, commercialisation was expected to occur via promotion of future outputs relating to disease control and improved production methods to the aquaculture industry. The anticipated effects for member companies were expected to be considerable

- One firm had increased production of scallops resulting from lower mortality rates which was expected to give rise to an anticipated 3 additional jobs, and significant increase in revenues.
- One firm, a commercial hatchery, had diversified into triploid oysters, and was experiencing continued growth in sales

6.3.11. Just over a third of the end-users, mostly aquaculture firms or organisations, were aware of future outputs from the projects from which they hoped to benefit. These outputs included improved vaccines and medicines, alternative fish feeds, improved methods of strain selection, and advice relating to more efficient farming techniques.

6.4. Conclusions

6.4.1. From this chapter it has emerged that a range of organisations beyond the research leaders' own benefit, or are thought likely to benefit, from the outputs of the individual projects. However, it is difficult to draw any firm conclusion as to how successful the Programme has been to date in externalising the outputs produced, since most of the beneficiaries identified had themselves had some direct involvement in Aquaculture Research projects.

6.4.2. In keeping with the nature of the project outputs, uptake tends to have been biased towards data and information sources. The survey also found a prevalence of less formal modes of dissemination i.e., word of mouth and general advice. It is, therefore, also difficult to assess the extent to which uptake has resulted in implementation or application of the findings, but the effects reported by the end-users are, as far as they go, positive.

6.4.3. It also appears that the processes of dissemination and uptake are in themselves a valuable exercise for the organisations involved in strengthening links externally and cross-sectorally.

6.4.4. Whilst commercialisation of the outputs to date has been relatively modest, the large proportion of end-users, including aquaculture businesses, who intended to pursue the research further is an encouraging sign.

- 6.4.5. However, although the general tone of these findings is positive, it is important to note that they were derived from a relatively small number of end users and wider beneficiaries that the contract leaders were able clearly to identify. Undoubtedly, it will be necessary in the future to ensure that outputs from projects in the Programme are more widely, or more effectively, disseminated.

7. PROGRAMME MANAGEMENT AND ADMINISTRATION

7.1. Introduction

7.1.1. Whereas earlier chapters in the report have been chiefly concerned with measuring the impacts of the Aquaculture Research Programme, this chapter is concerned with assessing its operational effectiveness. In what follows, various aspects of the Programme's management and administration are considered from different perspectives, including the contract leaders', end-users' and stakeholders'. The issues examined are Programme design and delivery, the appropriateness of the strategy, the review process, and lessons, if any, to be learned for the management and administration of similar programmes in future.

7.2. Rating of the Programme's operational effectiveness

7.2.1. Contract leaders were asked to assess aspects of the Programme's operation, and the results are shown in Table 7.1 below. Overall, it indicates that respondents' impressions of the operation of the Programme were generally favourable.

Call for proposals

7.2.2. The large percentage of those interviewed who were unable to comment on the call for proposals reflects the fact that many project proposals were agreed by consultation with MAFF, rather than through a formal call-for-proposals process. Amongst the remainder, all of whom rated this aspect as good, the reasons given were chiefly the absence of red-tape and the speed of the process.

Assessment of proposals

7.2.3. Overall, this was felt to be objective and well-handled although some felt that MAFF lacked sufficient internal expertise to judge all proposals effectively.

Scientific Appraisal

7.2.4. The consensus was that this aspect was sound and objective, although as some commented, they were unlikely to find fault with it given that their own proposals had been supported. However, one respondent felt that MAFF made insufficient use of external assessors.

Contract Preparation

7.2.5. More than two-thirds rated this aspect as good, identifying as reasons the absence of red-tape, the speed and efficiency of the process. This aspect of the Programme was compared favourably, by a significant number of respondents who had experience of both Programmes, with the equivalent aspect of the Aquaculture LINK Programme.

Project monitoring and evaluation

7.2.6. The monitoring and evaluation of projects received the strongest endorsement with almost 90% describing it as good. The strengths of this aspect of the Programme's operation were seen to lie in the non-intrusive manner in which monitoring was handled, and in the good relationship maintained between MAFF staff and the contract leaders.

Dissemination of results

7.2.7. Whilst half of respondents rated this aspect of the Programme favourably, a third were unaware of how and to what extent the results had been disseminated.

Table 7.1 How would you assess the operation of the MAFF Aquaculture Research Programme in terms of the following aspects? (% of contract leaders)

	Poor	Moderate	Good	Don't know/not applicable
Call for proposals	0	0	53	47
Assessment of proposals	0	6	61	33
Scientific appraisal	5	10	67	19
Contract preparation	0	27	68	5
Project monitoring & evaluation	0	14	86	0
Dissemination of results	0	13	54	33
Overall	0	17	78	6

Source: PACEC survey of contract leaders

7.3. Views of stakeholders on the management of the Programme

7.3.1. The discussions with stakeholders also explored how effective the management of the Programme was considered to be in assisting it to achieve its aims and objectives; and whether there were identifiable areas of strength and weakness in terms of design and delivery.

7.3.2. It should be noted that half of those interviewed stated that they were insufficiently familiar with the Programme's management to offer any assessment. Moreover, amongst those who felt able to comment, opinions were frequently qualified, ie based on limited knowledge, or an overall impression, not necessarily applicable to the whole Programme. Most of the comments offered by this group were favourable overall. Where the Programme's management was regarded as highly effective, factors that had contributed to its success were dialogue between researchers and industry or the dissemination of findings.

7.3.3. Notwithstanding the generally favourable comments overall, a number of shortcomings in the Programme's management was identified, amongst which no one theme or criticism dominated. Factors which were seen to hinder effective management included the following:

- the choice of projects, which was regarded as controversial or unreflective of industry's needs
- lack of industry collaboration in the design of the Programme or involvement in its running
- lack of communication, leading to duplication of effort or overlap with other programmes
- insufficient dissemination of results from the projects
- lack of transparency of the Programme as a whole
- the perception that the referees and assessors lacked neutrality
- a small number of organisations monopolised the funding available
- the Programme was unreasonably biased towards small companies, despite the difficulties faced by larger companies, such as feed manufacturers in securing funds for pre-competitive research.

Design and delivery aspects

7.3.4. Views on aspects of the Programme's design and delivery were mixed. Again any inferences drawn from the opinions reported here need to be mindful of the small proportions who were sufficiently familiar with the Programme to offer any comment.

7.3.5. A key design strength of the Programme was that it was perceived to be premised on real needs, i.e. those confronting the industry. Related to this,

some cited dialogue between MAFF and industry, and integrated into the design process, as a factor contributing to the Programme's success. The simple structure of the Programme was commended, as was the breadth of topics and issues encompassed by it. The discussions elicited that the most positive aspect of the Programme's delivery was the high profile of the Programme itself, resulting in widespread awareness at a general level, if not at the level of individual projects.

- 7.3.6. Although the discussions did not identify any aspect of the Programme's design that had inhibited its success, once again any interpretation needs to be balanced by the consideration that respondents tended to have at best a perfunctory knowledge of how the Programme operates. The single delivery aspect that was considered to have limited the Programme's success was the scarcity of available information arising from the research projects, in particular, early or interim publication of results. It also emerged from the survey that many stakeholders had difficulty in differentiating the Aquaculture Research Programme from the Aquaculture LINK Programme and this, indirectly, may be regarded as shortcoming of delivery.

7.4. Views on MAFF's strategy for aquaculture research

- 7.4.1. Respondents from three of the surveys were asked to what extent they were familiar with MAFF's strategy for aquaculture research and the results are shown in Table 7.2. What is surprising is that, overall, the end-users considered themselves to be slightly better informed than did the contract leaders.

Table 7.2 Familiarity with MAFF's strategy for aquaculture research
% replying as shown

	Very familiar	Fairly familiar	Not very familiar	Not at all familiar
Contract leaders	8	50	38	4
End-users & wider beneficiaries	4	60	24	12
Stakeholders	9	34	25	31

Source: PACEC survey of contract leaders & wider beneficiaries

- 7.4.2. All the surveys sought the opinions of respondents regarding how appropriate MAFF's Aquaculture Research strategy is to the needs of the industry.

Amongst the contract leaders who expressed a view, almost half considered that the Programme is sufficiently flexible and responsive to industry needs; and that MAFF ensures this by consulting widely in order to balance industry and research interests. These views were reflected to some degree by the end-users, and to a lesser extent by the wider beneficiaries. However, a sizeable body of opinion amongst the contract leaders argued that MAFF's strategy lacks a long-term view. For a few, the Programme was considered to have shifted overly towards near-market research and in this respect, the Programme was considered to lack continuity over time, historically having privileged strategic science over entrepreneurial projects. Others regarded MAFF's strategy as subject to pressures from industry lobbies, which hindered consistency in the long-term. The criticisms offered by the end-users centred on perceptions that the Programme could be more inclusive, addressing all sectors within the aquaculture industry, and inviting more collaboration from the industry. For their part, stakeholders were keen to emphasise the need for a strategy which prioritised diversification and addressed regional interests. On the whole, criticisms reflected sectoral interests: whilst some of the research leaders found the Programme scientifically unadventurous, end-users and wider beneficiaries tended to regard the Programme as insufficiently commercially oriented.

7.5. Views on the review process

7.5.1. Contract leaders, end-users and stakeholders were asked for their opinions on how the Aquaculture Research Programme review process might be improved. Suggested improvements clustered around two themes. Some considered that the process required more scientific rigour, or that it should make wider use of external assessors to ensure objectivity. A minority felt that the process was too onerous or rigid, and that projects were "over-reviewed." However, the majority considered that the review process worked well, and some commented that it had improved considerably over recent years.

7.6. Lessons for a future programme of aquaculture research

7.6.1. Contract leaders and stakeholders offered a variety of opinions on how MAFF's Aquaculture Research Programme should be developed in the future, particularly in light of the discontinuation of the Aquaculture LINK

Programme. The dominant message to emerge, across both groups surveyed, was the desirability of retaining links with industry in any future programme. Consultation with all sectors of aquaculture prior to the design stage was advanced as a way of ensuring that the resulting programme took into account industry priorities, even if collaboration was not always practical or possible. There was, however, considerable backing for funding to support active partnership between industry and research organisations, which was regarded as crucial to ensuring that the long-term objectives of such programmes are met.

- 7.6.2. Some advocated less bureaucracy generally and widening eligibility criteria to ensure a more evenly-balanced programme. In particular, it was considered that this would encourage smaller operators to participate. Related to this, arguments were put forward, mostly by stakeholders, for increased funding to support what were considered to be under-represented sectors.
- 7.6.3. A range of other suggestions were made, including establishing better links between researchers in order to facilitate technology transfer and pool expertise in particular fields. At present it was felt that projects were too fragmented and individual contract leaders did not always have a sense of participating in a coherent programme of research.

7.7. Conclusions

- 7.7.1. It emerges from this chapter that the Programme is well-received overall, in terms of its management and administration. Views on the operational aspects of the Programme from the contract leaders were very largely positive, particularly in the areas of project monitoring and evaluation. Some scope was identified for improving the review process by broadening the panel of assessors to include external experts.
- 7.7.2. The findings relating to stakeholders' views on the management of the Programme tended to be more mixed. There was seen to be a need to ensure that the Programme is more representative, in terms of reflecting industry concerns and, in particular, smaller sectors. A system of ensuring that results are externalised in a timely manner, and not necessarily after completion of a project, is considered necessary to maximise uptake by firms in the industry.

- 7.7.3. It is difficult to draw unambiguous conclusions about the appropriateness of the strategy to the needs of industry, given that these tended to reflect respondents' professional interests. Research professionals were more insistent on the need to ensure coherence in the long-term, with support for projects from fundamental to near-market stage, whilst industry respondents were keen to see projects that delivered benefits on a shorter time-scale. A follow-on programme might improve upon the current one by integrating industry into the programme from design to delivery, ensuring balance and inclusivity across aquaculture sectors, and improving communication between research organisations.
- 7.7.4. It is understood by PACEC that MAFF's strategy for future aquaculture research includes continued support for LINK-like projects. It, therefore, appears that MAFF's intentions accord with the preferences expressed.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1. Introduction

8.1.1. The purpose of this chapter is to address, in light of the earlier chapter conclusions, a series of questions arising from the evaluation aims and objectives set out in paragraphs 1.2.1-1.2.2. Attention then turns to recommendations following from some of these conclusions for a future Aquaculture Research Programme.

8.2. Conclusions

Is the rationale for the Programme valid?

8.2.1. The evidence presented in Chapter 2 provides a firm basis for concluding that the overarching rationale for the Programme is valid. The Programme addresses a range of needs and, consequently, different aspects of it have different justifications and rationale statements. However, it is believed that, where the Programme is based on a desire to tackle market failures, this could be made more explicit.

Are the aims and objectives of the Programme appropriate to the rationale?

8.2.2. Again, drawing on the findings presented in Chapter 2, it is apparent that the specified aims and objectives are widely considered to fit the rationale. The Programme's rationale is not premised on near-market issues and, correspondingly, the Programme's aims and objectives are considered appropriate to the circumstances of the aquaculture industry. To the degree that there is any dissent, this stemmed from a concern about the lack of explicit prioritisation and how, therefore, the aims and objectives translated in practice. It is also believed that, once they can be defined, consumer interests should be reflected in the aims and objectives.

What has the impact been on the capabilities of the participating organisations?

8.2.3. The Programme has delivered mainly moderate impacts on the capabilities and activities of the research organisations (Chapter 4, paragraph 4.2.1 and

Table 4.1). However, technical understanding and capabilities seem to have been substantially enhanced.

What scientific and technological advances have been made, and are they additional?

- 8.2.4. Chapter 4 also indicates that participants consider the advances associated with the projects to have been substantial to date and they are generally evenly distributed amongst the participating organisations (paragraph 4.3.1 and Tables 4.2). Almost all the recorded effects are additional, as it was found that deadweight and substitution effects associated with the projects were very small (Chapter 5, paragraphs 5.4.2-5.4.4 and Tables 5.2-5.3).

Has the Programme delivered a range of outputs for dissemination?

- 8.2.5. Outputs arising from the Programme have taken a range of forms, though they have been concentrated in knowledge-based forms, chiefly articles and reports (Chapter 4, paragraph 4.6.1 and Table 4.5). However, using a comparative measure, in terms of the number of outputs produced per project, the Programme has proved significantly less productive than the Aquaculture LINK Programme (paragraph 4.6.2).

Has the Programme been successful in delivering technology transfer?

- 8.2.6. A considerable amount of technology transfer has been associated with projects supported under the Programme (Chapter 4, paragraph 4.4.1 and Table 4.3). Although much of this has not been technology transfer in the strictest sense (i.e. based on the movement of intellectual property), the flows of information between research organisations, partner and non-partner organisations have been highly valued by participants.

Have the scientific and non-scientific objectives of the projects supported by the Programme been met?

- 8.2.7. It is clear that the majority of contract leaders considered the projects to be largely successful in terms of achieving their specified objectives, both scientific and non-scientific (Chapter 4, paragraphs 4.7.1-4.7.3 and Table 4.6). The evidence of external parties tended to endorse the view that the scientific quality of projects in the Programme had been, at minimum, satisfactory (paragraphs 4.8.2-4.8.6).

What are the likely future public effects and private benefits?

- 8.2.8. The future benefits are likely to take the form of further research, and technological and scientific advances. Progress towards commercialisation has been limited to date (Chapter 5, paragraphs 5.2.1-5.2.2 and Table 5.1) and does not appear to be a priority for the majority the contract leaders. However, this balance is to be expected given that the Aquaculture Research Programme is not designed to support near-market research.

What have been the wider effects of the Programme?

- 8.2.9. The Programme has given rise to a number of spin-offs and wider effects, scientific, commercial and environmental (Chapter 6, paragraph 6.2.1 and Table 6.1). Additionally, some valued links have been established between research and commercial organisations (Chapter 6, paragraphs 6.3.1-6.3.11), although the number of wider beneficiaries identified during the course of the evaluation was rather small.

How effective is the management and administration of the Programme?

- 8.2.10. The consensus of participants in the projects is that the Programme is effectively managed and administered on an operational level (Chapter 7, paragraphs 7.2.1-7.2.7 and Table 7.1). The Programme was subject to some criticism from stakeholders (albeit largely based on a partial knowledge of the Programme) from which it is inferred that the Programme review process might be made more transparent.

What are the lessons for a future Aquaculture Research Programme?

- 8.2.11. At a strategic level, some conflicting views co-exist surrounding the direction which future aquaculture research should take; broadly, whether the emphasis should be on addressing long-term strategic issues, or on those of more immediate concern to the industry. It is difficult to see how these might be accommodated in one programme (Chapter 7, paragraphs 7.4.2 and 7.6.1-7.6.3). Specific recommendations are covered in more detail in section 8.4 below.

8.3. Comparisons with the Aquaculture LINK Programme

- 8.3.1. In terms of the quality of the projects supported under the Aquaculture Research Programme, little has emerged from this evaluation which

differentiates it from the projects in the Aquaculture LINK Programme. The great majority of projects have delivered scientific and technological advances and have been largely successful in meeting their stated objectives. In both cases, external assessments of the projects rated the scientific quality favourably.

- 8.3.2. There is some evidence that the Aquaculture Research Programme has been less fertile in producing projects outputs than the Aquaculture LINK Programme. Contract leaders were measurably less prolific in terms of published outputs than were the research partners in the LINK Programme. Technology transfer in the sense of intellectual property was not generated to a significant degree by either Programme; nevertheless, information flows and transmission of know-how between organisations were considerable in both cases, and seem to have contributed significantly to the value derived from participants.
- 8.3.3. There has been markedly less progress towards the commercialisation of outputs arising from the Aquaculture Research Programme than under the Aquaculture LINK Programme. In both cases, the progress referred to more often took the form of opportunities identified rather than actual exploitation. Considering the orientation of the LINK programme, which was designed to secure the involvement of industrial partners in pre-competitive research, these divergent outcomes are unsurprising.
- 8.3.4. Some differentiation is possible between the two Programmes in terms of their management and administration, with the Aquaculture Research Programme emerging as the slightly more effective of the two on an operational level. However, any interpretation of this finding should bear in mind that unlike the LINK programme, the projects in the Aquaculture Research Programme typically comprised only one contracting organisation, rather than a number of partners, academic and industrial, and consequently the administrative and management demands of the Programme may reasonably be assumed to be considerably less complex.

8.4. Recommendations

- 8.4.1. On the basis of the evidence presented in earlier chapters and summarised here, it is concluded that the Aquaculture Research Programme has been largely successful in meeting its stated objectives, although some outcomes and effects are yet to be realised. Nevertheless, some considerations have emerged for the management and administration of a similar Programme in future.
- 8.4.2. Any examination of the Programme should take due account of the fact that, in its current form, the Aquaculture Research Programme occupies an intermediate position between research of a fundamental nature (which tends to attract Research Council funding) and pre-competitive research (which attracts funding from private investment and by programmes such as the Aquaculture LINK Programme). A programme of this kind is considered both desirable and necessary, as the enduring validity of the programme's rationale demonstrates. In light of this, modifications to the design and delivery of the Programme are considered to be more appropriate than a radical shift or re-specification.
- 8.4.3. Despite the fact that the Programme's over-arching rationale and thematic rationale statements are believed to be valid, it is recommended that they should be revised to ensure that market failures which necessitate the Programme are defined more explicitly, rather than simply being alluded to, as at present.
- 8.4.4. As it was indicated in paragraph 8.2.9, uptake of project outputs has to date occurred over a relatively narrow and self-selecting base, largely restricted to those with some prior involvement in the Aquaculture Research Programme. Given that exploitation of opportunities arising from the Programme largely depends on third party initiatives, a future programme should incorporate more forceful measures to ensure that more research outputs are placed in the public domain to maximise externalisation and subsequent uptake by a wider audience. In particular, it is recommended that proposals for funding under the Programme should make clear who the intended research output users are, and how the outputs will actually be disseminated to them. (It is acknowledged, however, that one of the main contracting organisations in the

Programme, i.e. CEFAS, has already been recommended to place greater emphasis on publication of research findings and their dissemination).

- 8.4.5. In relation to the conclusions drawn earlier in the report and summarised in paragraph 8.2.10, it is recommended that a future programme should seek greater involvement from industry in structuring its priorities. Although the Programme as it currently stands is not designed to be collaborative by nature, it is believed that ensuring greater dialogue, both at the design stage and throughout, would go some way to addressing concerns regarding under-representation of some sectors and the relevance of a future Programme to industry priorities. (It is acknowledged that the 1999 Programme Review did entail greater efforts than previously to consult industry, but the need to improve in this respect evidently remains).

APPENDIX A: PROJECTS SUPPORTED BY THE AQUACULTURE RESEARCH PROGRAMME

Project code	Project title	Start date	Completion date	MAFF funding, £
FC0107	Environmental control of halibut broodstock and rearing procedures for feeding larvae	04/93	03/98	515,400
FC0108	Further studies on the digestive physiology of juvenile dover sole	10/94	03/97	79,126
FC0114	Tool for modelling sealoch ecosystems	01/96	12/96	29,280
FC0117	An economic appraisal of cod farming	11/95	11/95	2,200
FC0120	Abnormal sex ratios in Dover sole	06/96	03/98	134,730
FC0202	The hatchery production of king scallop seed	14/98	03/02	753,454
FC0203	The environmental impact of clam cultivation	04/90	03/96	668,093
FC0210	Desktop study of scallop (pecten maximus) cultivation in the UK	04/95	06/95	11,100
FC0211	Tetraploid Pacific oysters	04/95	03/98	246,216
FC0212	Scallop seabed cultivation development	06/95	03/96	30,000
FC0215	Enhancing growth and survival of hatchery produced scallops	04/96	03/98	88,513
FC0218	The potential for Abalone Aquaculture in the UK	01/97	03/97	3,000
FC0303	Lobster stock enhancement experiment	04/90	03/96	286,701
FC0312	Lobster stocking programme	04/95	03/97	40,000
FC0313	Factors governing carrying capacity of artificial lobster nurseries	04/95	03/98	203,534
FC0421	Studies of proliferative kidney disease	01/94	12/96	128,244
FC0425	Re-testing antigens against Lepeophtheirus salmonis salmon	01/95	01/96	28,329
FC0604	Studies of veterinary medicines used in fish farming	04/93	03/98	1,069,581
FC0901	Environmental influences on the sex of cultured marine flatfish	04/98	03/02	321,706
FC0902	Quality of hatchery reared flat-fish	04/94	03/00	260,454
FC0903	Sex control in turbot	04/95	03/00	553,348
FC0904	Spawning of flatfish in captivity - sex pheromones and reproduction in flatfish broodstocks	01/96	06/99	60,451

/ continued

Project code	Project title	Start date	Completion date	MAFF funding, £
FC0905	Halibut egg and early larval rearing	04/95	09/98	20,000
FC0906	Dietary lipids and cold tolerance in juvenile flatfish	10/95	01/00	60,451
FC0910	Optimisation of formulated diet for marine fish larvae	03/97	03/98	26,803
FC0911	Optimisation of formulated diet for marine fish larvae	04/98	03/01	274,575
FC1001	Transport of seed scallops - Pecten maximus	02/96	01/99	147,944
FC1002	Nursery cultivation of king scallops	04/96	03/00	488,679
FC1005	Assessment of the impact of different types of sewage treatment on the contamination of shellfish	10/97	03/00	68,621
FC1008	Depuration of razor clams	07/98	03/99	26,000
FC1011	Development strategy for the UK shellfish cultivation industry	02/00	03/01	45,000
FC1101	Quantitative evaluation of bivalve disease susceptibility and resistance	08/95	11/98	27,764
FC1102	Rainbow trout fry syndrome - Phase II	01/00	10/03	185,152
FC1110	Studies of chemotherapeutants to treat fish diseases	09/96	10/99	71,500
FC1112	Investigations into the lifecycles of myxosporean parasites, including the agent of PKD	04/97	03/00	212,382
FC1114	PKD lifecycle studies with particular reference to the infective stage and the development of effective control strategies	01/97	12/99	116,540
FC1117	An investigation into the natural disease status of wild scallops from UK coastal waters	01/98	01/99	19,600
FC1125	Factors affecting the disease susceptibility of farmed fish	04/98	05/03	903,300
FC1126	Designing fish for disease resistance	02/98	01/99	47,723

APPENDIX B: TOPICS COVERED BY QUESTIONNAIRES AND INTERVIEW STRUCTURES

Survey contract leaders.

The outline presented below applied to the in-depth interviews with contract leaders in selected projects. A similar, but shortened version was used for other interviews with contract leaders.

1. Respondent's characteristics
 - contact details
 - location
2. Project description
 - reference number
 - project title
 - description of project
3. Reasons for participation
 - objectives
 - reasons for seeking support from MAFF Aquaculture Research Programme
 - effect participation had on other projects (i.e. did participation displace other projects that would have yielded benefits)
4. Project costs & inputs
 - other sources applied to for funding
 - level of funding sought from MAFF
 - impact on project as a result of reduced funding
 - sources of any other inputs received in cash or in kind
5. Impact on activities and technical capabilities
 - effects on activities and capabilities (increased R&D activity, accelerated technical progress, improved technical understanding, improved skills, greater understanding of needs, greater ability to work with industry/research organisations)
 - assessment of significance of technological advances made
 - number of publications arising from the research (scientific journals, conferences, trade journals, conferences, seminars, etc.) - actual and anticipated
6. Commercial/financial impact
 - progress made towards commercial exploitation of any outputs (opportunities identified, further action, actions built into business plans, follow-on R&D, etc.)
 - quantification of commercial or financial benefits to the participant - for research organisations, this refers only to financial benefits over and above those accruing as a direct result of participation)

7. Wider effects
 - spin-off scientific and/or commercial ideas (internal or external to project partners)
 - benefits to other organisations from uptake of project outputs (i.e. potential wider beneficiaries outside project groups)
 - social benefit (environmental, public health and safety, other)
10. Operation of the Programme
 - Assessment of the management and administration of the Programme
 - Assessment of MAFF's Aquaculture Research strategy and its appropriateness to the industry
 - Suggestions for development of a future Programme

Survey of projects not implemented

The questionnaire was used for projects proposals that were rejected followed the structure outlined below:

1. Respondent's characteristics
 - contact details
 - size according to employment and turnover (industrial companies)
2. Project description
3. Reasons for proposal and subsequent rejection
 - objectives
 - reasons for seeking support fromh MAFF Aquaculture Research Programme
 - assessment of reasons for failure of application
4. Outcome
 - extent to which the project proceeded in the absence of Aquaculture Research funding (not at all, delayed, reduced timescale, reduced scope of R&D, fewer partners, etc.)
 - progress made towards commercial exploitation of any IPR developed (opportunities identified, further action, actions built into business plans, follow-on R&D, etc.)
 - estimation of technological impact / commercial impact of failure to secure funding (opportunities foregone, or lost to competition abroad) - for research organisations, this refers only to financial benefits over and above those accruing as a direct result of participation)

Survey of wider beneficiaries.

1. Respondent's characteristics
 - contact details
 - size according to employment and turnover (industrial companies)
 - location
 - principal product/service (companies) or discipline (research organisations)
 - whether respondent had any direct involvement in Aquaculture Research Programme
2. Use of project outputs
 - research reports
 - intellectual property / technologies
3. Effects of using outputs
 - effect on research capability
 - effect on teaching quality and relevance (academic organisations)
 - effect on business capability
 - effect on business performance
4. Future use of outputs
 - Awareness of any future outputs arising from projects
 - Intended use of future outputs
5. Programme operation and development
 - Assessment of MAFF's Aquaculture Research strategy and its appropriateness to the industry
 - Suggestions for development of a future Programme

Survey of stakeholders

A more open discussion agenda was for the purpose of interviewing the Programme's wider stakeholders. The topics covered are set out below.

1. extent to which the rationale for the Programme is still valid
2. extent to which the Programme's aims and objectives are appropriate in light of the rationale
3. views on the effectiveness of the management of the Programme
4. aspects, if any, of the design and delivery of the Programme that inhibit project success
5. assessment of the scientific quality of projects and the Programme overall
6. assessment of the commercial benefits arising from the projects and the Programme overall
7. views on how the Programme's design and delivery might be improved
8. views on what might be done to promote aquaculture research that is relevant to industry.

APPENDIX C: STAKEHOLDER ORGANISATIONS SURVEYED

Aquaculture businesses & suppliers

- Caledonian Trout Company
- Scot Trout
- Orkney Marine Hatcheries Ltd
- Joseph Johnstone & Sons
- BioMar Ltd
- Trouw Aquaculture
- Marine Harvest McConnell
- Ingleside Big Brae
- Myti Mussel Ltd
- Deep Dock Ltd
- Mainland Salmon Ltd
- Glenkens Fish Farming Ltd
- Landcatch
- Alharma
- Roche Products Ltd
- EWOS Technology Centre

Trade Associations

- Seafood Scotland
- International Fishmeal & Oil Manufacturers Association
- Association of Scottish Shellfish Growers
- British Marine Finfish Association
- Scottish Quality Salmon

Research Organisations

- The Institute of Freshwater Ecology

Government Agencies

- Department of Environment, Regions and Transport
- Food Standards Agency
- Scottish Executive Rural Affairs Department
- Scottish Environmental Protection Agency

- NAWAD

Environmental

- Friends of the Earth Scotland
- National Office of Animal Health
- Scottish Natural Heritage
- English Nature

Other

- The Crown Estate

APPENDIX D: SUMMARY OF RATIONALE STATEMENTS

- 8.4.6. **FC01 Marine Finfish Production:** Halibut, turbot and cod have been identified as promising candidates for future farming. Halibut is considered to have potential in the medium term, and MAFF is funding basic, far-from-market research to establish the full potential and investigate scope for diversification. More broadly, research is needed to investigate fish species and cultivation techniques which show potential for future development by the industry. Research is also needed on the environmental aspects of aquaculture. Thirdly, MAFF requires research in order to fulfil its advisory capacity to industry. The work being undertaken on this topic seeks to remove technical constraints on and provide a scientific basis for the development of aquaculture and related activities.
- 8.4.7. **FC02 Molluscan Production:** The principal concerns forming the rationale for MAFF's work in this area are as follows:
- Fulfilment of regulatory responsibilities eg Several Orders, controlling the spread of disease/pests, and monitoring non-indigenous species introductions.
 - Promoting and encouraging molluscan aquaculture. This includes investigation of new methods of production and rearing, and investigating new candidates for cultivation, including non-native species which will in turn reduce the pressure on wild stocks.
 - Monitoring the impact of shellfish cultivation on the environment, particularly with non-native species where there are concerns about possible displacement of native species. As pressure grows from the industry to allow cultivation of new species, MAFF needs to be in a position to provide sound environmental guidelines on acceptable levels & methods.
- 8.4.8. **FC03 Crustacean Production:** Coastal fisheries are important to local economies, with lobsters forming a particularly high value resource. However, they are subject to heavy fishing pressure, and there is a need to explore alternative ways of enhancing lobster stocks, thereby increasing production, through the establishment of new lobster populations. A 10-year trial programme of stock enhancement began in 1983. MAFF's role in this area is one of supporting the development of an efficient aquaculture industry, the

work being regarded as far-from-market. It is also consistent with MAFF's coastal management obligations.

8.4.9. **FC04 Fish Disease:** The rationale is twofold:

- Serious fish/shellfish diseases are responsible for high mortality rates in fish and shellfish populations which are potentially damaging to both farmed and wild stocks and hence to the aquaculture/fishing industry. In the case of wild stocks especially, disease has ramifications for conservation, and if uncontrolled, ultimately for producers and consumers. MAFF therefore has a role to play in monitoring fish/shellfish health in order to fulfil its responsibilities for notification and control of disease, minimising disruption and extra costs to the market.
- Fish disease is a major constraint to the development of the aquaculture industry. Advances in the control of disease can have a substantial positive effect on productivity; far greater, for example than advances in nutrition.

8.4.10. **FC06 Medicines/Advice to VMD:** A range of antibiotics and other chemicals are routinely used in fishfarming, although few have been specifically licensed for aquacultural use. A wider range of products is likely to be used in the future due to pressures of disease, performance, intensification and the advantages or disadvantages of some drugs/chemicals relative to others. Assessments of safety in the aquatic environment create a need for special scientific knowledge in relation to the diffusive nature of water and the cold-blooded physiology of most aquatic organisms and for these aspects the Fisheries Directorate is called upon to advise the Veterinary Products Committee. Research is needed to enable the Ministry to provide advice on the residues of chemicals used to treat fish and to investigate the possible effects of drugs on the environment.

8.4.11. **FC07 Fish & Shellfish Health:** Bivalve molluscs are capable of accumulating human pathogens through their feeding process, eg from sewage effluents, and acting as carriers for naturally occurring marine biotoxins. In the last decade, high levels of contamination, eg on the north-east coast, have fuelled public concern about shellfish toxicity. MAFF has responsibilities under UK & EU legislation for the control of public health hazards arising from fish & shellfish consumption. Research projects under this topic, therefore, underpin MAFF's advisory role, or are directly aimed at reducing

risks to public health. (There are, however, no projects currently supported under this topic area in the Programme).

8.4.12. **FC 09/10 Fish Farming & Shellfish Cultivation:** This is summarised under three topic areas:

- *Trout farming*

The trout farming industry in England & Wales is dominated by SME's and provides employment in rural areas. Production has plateaued over recent years, and is mostly geared to the domestic market. To remain competitive, producers must adopt methods of production that ensure consistent, high quality products, and meet consumer demands/public concerns (eg on animal welfare). The industry already supports research on a small scale, to maintain its competitive position. However, the small and fragmented nature of the industry militates against greater resources being devoted to more speculative R&D projects.

- *Marine fish farming*

Pressure on wild stocks resulting in price rises, together with the desirability of sustainable supplies, suggests there is scope for diversification amongst the aquaculture industry. However, significant barriers exist to the development of a cheap mass market species, namely the GB climate, consumer preferences and costs of production. There is a stronger case for expansion into new high value species, as the salmon industry has demonstrated. Research is needed to support the industry in overcoming the technical constraints associated with the farming of such species (halibut, turbot and cod), in particular the problem of diet for larval finfish.

- *Shellfish cultivation*

The main species currently cultivated are mussels, oysters and clams, much of production being exported. Potential exists both for expansion, particularly of mussels, and for diversification into scallop farming, but three difficulties arise. Firstly, the small scale of production interposes a problem between farmers and retailers/processors, the latter requiring consistent supply of a standard product. Secondly, marketability of shellfish is reduced due to the small proportion which comply with the highest classification under the Shellfish Hygiene Directive. Thirdly, shellfish cultivation gives rise to environmental concerns about wild mussel seed stocks and the impact on birdlife. The industry is composed of small businesses, for whom the costs and risks of the R&D required to assist the development of the industry are too much to bear.

