

IDRC CONFIDENTIAL

MOLLUSC CULTURE PROJECTS : AN EVALUATION

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Planning &
Evaluation**

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Mollusc Culture Projects: An Evaluation

Acknowledgements

- To undertake an evaluation of six projects located in three regions of the world is logistically very time consuming. The support provided by IDRC staff in arranging project visits, interviews, and facilitating the collection of information necessary for this evaluation has made my task much easier. Particularly, I wish to thank Brian Davy (Assoc. Dir.), Ramon Buzeta and Howard Powles of the Fisheries Program, AFNS; Lisa Ormsby and Robin Hallam, Operations Group, AFNS, Bev Chataway and Margo Hawley, Library, Information Sciences. I wish also to express a special note of thanks to Chris MacCormac of the Agricultural Economics Group, AFNS for his valuable comments and assistance during the course of this evaluation.

- This evaluation would also not have been possible without the enthusiastic cooperation and participation of the project leaders and staff of the six projects being evaluated and the logistical support provided by the Governments of Jamaica, Sabah, Singapore, Sierra Leone and Sudan during project visits.

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FOREWORD

In response to a request from the Associate Director, Fisheries Program, Agriculture, Food and Nutrition Sciences Division (AFNS), the Office of Planning and Evaluation (OPE) undertook an evaluation of six mollusc culture projects that had been funded by the Centre. The request from the division was to assess the attainment of the projects' objectives (summative evaluation), and to provide recommendations for future prospects and program directions (formative evaluation). With both of these components, the study provided an opportunity for the Fisheries Program staff of AFNS to review the history of Centre funding and to arrive at some plan of action for the future. The response of the Associate Director of the Fisheries Program to the evaluation is included in this report and provides an opportunity for readers to be informed of the future directions to be taken by the Centre towards funding mollusc culture research.

This evaluation incorporates the operating evaluation principles adopted by OPE for the Centre's planning and evaluation requirements. Because of our emphasis on tailoring evaluation studies to meet user needs and to ensure the utilization of evaluation findings, the division underscores the importance of concentrating as much effort on discussion and liaison with the users of the evaluation and the project recipients (the evaluation process), as on the methodology and the final report. Part of this process entails a dialogue between the users and an OPE staff member concerning users' needs, the scope and nature of the evaluation, the objectives of the evaluation, and the resources available or to be committed. It also consists of continuous liaison and information updates to the users throughout the course of the evaluation cycle. Clearly, this "interactive approach" (to borrow a phrase from the Associate Director of the Fisheries Program) has met with a positive reception as the response of the Associate Director, Fisheries Program has shown. However, considerable staff time had to be allocated for the evaluation in order to take this approach. All the input from OPE, including writing the following report, was provided by a member of our staff, Sing Chew.

The evaluation methodology included also market potential surveys undertaken by Third World consultants in the three regions where the projects are located. Financial analyses were also undertaken to assess the potential of future transfer of technology. The findings from the market potential surveys indicate the unlikelihood that oysters and mussels could become an important food source for the poor given the likely production costs. While this might seem to be a very discouraging finding, the promising production and potential export possibilities could provide significant income and employment benefits to some of the poorest communities in the Third World. Exploiting this potential by revising production research objectives and broadening the scope of research to include economic, processing and marketing research could represent a real challenge for the AFNS Division but one which it is well placed to meet.

A shorter version of this report including its findings will be prepared for journal publication to ensure wider dissemination. It is pleasing to note that a recently completed independent review of the oyster culture project in Sierra Leone undertaken by T. R. Brainerd of the International Center for Marine Resource Development, University of Rhode Island, U.S.A., arrives at similar conclusions to this evaluation. I am also very pleased to see that the evaluation has been met with a warm response by the Fisheries Program, AFNS Division.

Doug Daniels,
Director,
Office of Planning & Evaluation

SUMMARY

ORIGINS AND RATIONALE OF PROJECTS

1. a) The objectives of the six projects reflected the funding objectives of the Centre. The main objectives of the six projects were to conduct research on the growth conditions of molluscs in suitable tropical waters and to train scientific and technical personnel to undertake these research tasks. It was envisaged from these studies that viable mollusc culture systems of food production for the rural poor could be developed and transferred.
- b) There were minor differences between Centre Program staff and two project recipients (Jamaica and Singapore) with respect to the markets for which the molluscs were being cultivated. However, these differences were discussed and settled during project activities.
2. a) Generally, in the area of the development of project proposals, we find IDRC program staff response to the initial requests to be reflective of the style and operating philosophy of the Centre. However, there was active stimulation on the part of IDRC program staff to develop the project in Sierra Leone. A delay of one year in terms of responding to recipient request occurred during the development of the project in Peru. The busy travel schedules of program staff were given as reasons for the delay.
- b) There were also substantive changes made to the research proposals of two projects (Peru and Sudan). The changes made by IDRC program staff narrowed the scope of the proposed research, and in our view, structured the projects into a more manageable set of research activities.

THE OBJECTIVES OF THE PROJECTS AND OUTCOMES

1. a) All projects did not reach the stated objectives of the project summaries. Furthermore, it must also be stated that for the objectives attained, some of the findings might be inconclusive.

b) Reasons for not attaining these objectives are:

i) Research/Extension and Institutional Capacities: In our view, the research and institutional capacities to undertake research activities in mollusc culture were not adequate (with the exception of Singapore) to fulfill these tasks, if we consider that the main emphasis of these projects was to undertake scientific research to produce useful research results. Training was provided to project recipients to upgrade their research capabilities, though this was not the main thrust of these projects. Permanent and temporary project staff departures further affected this condition.

There was also a lack of trained extension personnel on the project teams (with the exception of Jamaica) even though project objectives included dissemination and transfer of the developed technology.

ii) Lack of Continuous Government Support: The absence of continuous government support affected the progress of the projects in Sierra Leone and Malaysia. The lack of continuity in government support was attributed to economic conditions and in the case of Malaysia, was complicated by personality conflicts.

2. a) In light of the above, the original objectives of the six projects were too ambitious considering that the recipients not only had to produce research results, but as well, to undertake the dissemination and transfer of the developed

technology. We are led to ask whether the first phases of the six projects should have emphasized and concentrated on primarily training and upgrading of the researchers to conduct mollusc culture research with a lesser emphasis on undertaking research activities to produce research results.

- b) Changes in Objectives after Project Implementation: Two projects (Jamaica and Peru) had their objectives changed during the course of project activities. For the Jamaican project, the objective to produce a low cost protein for the rural poor was shifted towards producing a cash crop for sale in the local tourist and hotel trade. Reasons for this shift were the high production costs and the low market demand for oysters by the rural poor in Jamaica. In the case of the Peruvian project the number of species of molluscs to be studied were reduced and the research activities were shifted solely towards scientific studies. The decrease in the number of molluscs studied was accounted for by the changes in environmental conditions but the shift towards concentrating solely on scientific activities appeared to be groundless.

TRAINING AND USER DEMONSTRATION

1. a) The training provided was completed successfully. A total of 29 persons were trained. All trainees (3) sent for degree courses (MSc) completed their program successfully.
- b) Trainees with no background in mollusc culture research were able at the end of the training to have some understanding of mollusc culture research. However, from the technical consultants' reports, the quality of the research undertaken post training indicated that there is room for improvement.

- c) The areas of training suggested by the project recipients have to be considered carefully. In light of the needs of the projects, skills in socio-economic analysis, processing and marketing techniques are required for future project activities. The question is whether training should be provided in these areas to project personnel, or staff with expertise in this area be included in future project teams.
2. a) The dissemination and user demonstration of the developed culture processes were undertaken in only four projects (Jamaica, Singapore, Sierra Leone and Malaysia). The success of the farmers adopting the culture process varied among the projects. The only projects which have exhibited successful transfer are Jamaica and Singapore. We have identified certain factors which we believe facilitated successful transfer : provision of extension officers, greater emphasis in project activities on extension work, financial support such as capital start-up funds for prospective farmers and the lack of other viable economic opportunities. Given the absence of some of these factors in some projects, it is to be expected that a low adoption rate of the developed culture process was encountered.

RESEARCH CAPABILITY, CONSULTANTS AND LINKAGES

1. a) The presence of the projects in the six countries did increase the scientific capabilities of the project personnel to the extent that they were able to undertake mollusc culture research. A total of 93 project personnel benefited from the presence of these mollusc research projects in the six countries in terms of opportunities to undertake mollusc culture research and development.

- b) The use of consultants increased the research capabilities of the project staff and longer consultancies were requested by the project staff. Furthermore, more monitoring visits by IDRC program staff were encouraged by the project recipients as these visits would provide not only technical advice but also the necessary support for their project activities.
2. In terms of the development of institutional linkages between project recipients and other institutions, three projects had developed these linkages. Most of these linkages were at the liaison level; however, in the case of Sudan project, the liaison activities have led to the contribution of financial support from the regional government where the project research sites are located.

FINANCIAL ANALYSIS OF CULTURE PRODUCTION SYSTEM AND MARKET POTENTIAL OF MOLLUSCS

1. Of the six projects evaluated, 4 projects had developed a culture production system which could sustain continuous culturing of oysters. The viability of these systems were considered only with respect to the biological culture process. In terms of successful transfer of the culture production process, only two projects showed indications of adoption by local farmers : Jamaica and Singapore. The Jamaican project had continuous local government support that facilitated the successful transfer through the provision of extension services and capital start-up funds. No doubt, market potential and local employment conditions also affected the successful transfer.
2. i) The market potential studies suggest that the market for molluscs is not one of unlimited demand. Molluscs

consumption are concentrated mostly in the temperate northern countries with the exception of the consumption of mussels in Thailand.

- ii) The local market potential for oysters in Malaysia, Jamaica and Sierra Leone are limited. Market potential studies also suggest that in the case of Sierra Leone, the amounts are consumed by the urban and upper strata of Sierra Leonean society. There is, however, a potential for the oysters produced to be exported to the markets overseas. In this regard, cost of production, post harvest processing and handling would have to be examined carefully.
- iii) The local market demand for mussels is low and the only avenue for the products produced by the developed techniques of the Singapore project would be for export. This is currently being done. Because mussels are considered the poor man's food, further export increases would be contingent on lowering the cost of production.
- iv) There is a local demand for scallops in Peru and the consumption increase is estimated at 25% annually. Like the case in Sierra Leone, scallops are consumed in Peru by the upper and middle income segments of Peruvian society.
- v) With the available information to date there is a market for the mother-of-pearl oysters in Sudan and overseas. The possibility of these oysters being used for animal feed further increases the market potential of the product.

3. i) Financial analysis indicate that it would be profitable to culture oysters in Sabah where a one-acre farm would provide sufficient income that will be attractive to artisinal fishermen. As a part-time venture, a 0.5 acre farm is proposed. These calculations are based on experimental production systems. Other factors such as local employment opportunities and the availability of capital start-up funds would also have to be considered. The current availability of other employment opportunities and the lack of capital start-up funds in Sabah would hinder the adoption of the developed culture process.
- ii) For the Jamaican project, a minimum of 4 rafts will be needed if a fisherman is to consider undertaking oyster cultivation as an extra source of income. Approximately 10 oyster rafts will be required if a fisherman is to undertake it as his primary source of income. In our view, considerable government support and input will be needed continuously in order for this activity to be undertaken successfully. Currently production support is provided to fishermen who have adopted the culture production process.
- iii) The financial analysis undertaken for the Singapore project indicates that substantial capital start-up funds are needed to undertake the developed culture process. It requires a labour input of approximately five persons which would shift the production operations to a scale much larger than a family size farm.
- iv) The financial analysis of the Sierra Leonean project is inconclusive. Raft and rack cultures are considered suitable for production operations. It would be

financially difficult for a prospective fisherman to undertake the costly raft culture process developed by the project in view of the current economic conditions in Sierra Leone.

4. In our view, the optimum modality would be to locate projects in government ministries with university departments providing research support.

RECOMMENDATIONS

1.0 Rationale of Projects

It is doubtful that the culture systems developed would be producing molluscs at a reasonable cost as a protein source for the rural poor. The lack of a high local demand for these molluscs in some of the countries (Jamaica, Malaysia, Singapore) where the projects are located further restricts the possibility of the molluscs being consumed by the rural poor. **In view of this, the Fisheries Program should re-examine its overall rationale for supporting mollusc culture research.** The findings of the evaluation suggest that the rationale of funding should be shifted more towards the provision of economic opportunities for the rural poor, rather than food for them.

2.0 Research

2.1 All the projects did not achieve their stated research objectives, **we recommend that the research capabilities and institutional capacity of the prospective recipient be evaluated carefully and appropriate training and logistical support be provided to build up these capabilities before expecting the recipient to undertake successful mollusc culture research.** Furthermore, IDRC support should be tailored according to the different levels of research and institutional capacities of project recipients.

For new projects, it might require first phases of projects to be devoted mainly to training and the research activities undertaken as capability building exercises. What this means is that sustained IDRC support should be provided in the form of more phases of the project if the recipient shows the potential, motivation and interest to conduct mollusc culture research.

2.2 In view of the findings of the evaluation, **we recommend that the Fisheries Program consider undertaking market potential studies prior to**

the start of each project so as to guide the type of culture system and post production process to be developed and to also consider whether it is economically viable to establish culture production systems for the countries in which the projects are to be located. The latter would require consideration of factors such as government support, conducive local contexts (work habits, cultural milieu) and the political economy of the country or region in which the project is to be implemented. The new criteria established for writing of project summaries offers a guide to this appraisal process.

2.3 If future support for the six projects is being considered, we recommend that the Fisheries Program consider ways to improve the quality of the research activities undertaken by the recipients. Technical consultants' reports have noted of the lack of persistency in continuing research trials, recording of data, and critical scrutiny of data collected. Modalities such as the provision of longer term consultancies or networking can be considered to overcome these past practices. Networking would be an avenue which could provide a peer review of ongoing research practices since periodic meetings would be held to discuss problems and progress. Network meetings would encourage recipients also to report their problems, since progress reports from some recipients in the past are infrequent. The Network Evaluation Study completed in 1980 indicated that this peer review exercise would strengthen research capability. However, it also warned that stronger research teams in the network might be hindered in terms of rapid progress. If this modality is chosen, the appointment of a network coordinator with experience in mollusc culture research and development should be considered. This would provide technical input for the projects, and also common and consistent advice.

2.4 Because of the limited success in the transfer of the developed production process to farmers, we recommend that for future projects consideration be given to include the view and needs of the targeted beneficiary of the projects into the design and research activities of the projects.

2.5 We recommend that the Fisheries Program consider carefully the future areas of mollusc culture research identified through this evaluation. Particular, the development of hatcheries should be examined in light of the evaluation visits. Such an assessment should consider the economics of utilizing hatcheries to produce spat for grow-out.

3.0 Training

3.1 Besides biological knowledge, various skills are required to undertake mollusc culture research and development. We recommend the inclusion of personnel trained in socio-economic analyses and extension activities be included in future project teams. These individuals can be seconded from other governmental ministries. It would lead to further involvement from other ministries which could result in better institutional linkages that are lacking for some of the six projects evaluated. A latent function might be that with this involvement of several ministries, continuous government support could be more forthcoming in projects which suffer from this symptom.

4.0 Culture Production System and Technology Transfer

4.1 We recommend that the Fisheries Program consider including financial analysis of the culture production system as part of project activities. This calculation of cost of production should be undertaken during the development of the culture system so as to ensure that the cost of the developed system will not prohibit prospective farmers from adopting the developed process. It will also ensure that the cost of the molluscs produced can be afforded by the consumer.

4.2 We recommend that extension and dissemination activities be strengthened and supported. For dissemination purposes, and even extension, it might be useful to consider NGOs for these activities.

5.0 Other Recommendations

5.1 We are concerned about the progress of the Peruvian project. Of the six projects evaluated, the Peruvian project is the only one which in our view has achieved the least progress, considering the amount of funds spent to date. The isolated nature in which the research is being conducted by two university researchers and the lack of any sufficient governmental support raise the issue of whether this project will even reach the dissemination and transfer of technology stage. **We recommend that if further funding is being considered for this project, the participation and collaboration of other agencies involved and responsible for aquaculture activities in Peru should be considered.** In an **Overview of Peru's Fishing Industry** in terms of prospects and problems funded by LARO, this report has listed institutions such as Instituto del Mar del Peru (IMARPE), as a fisheries research centre in Peru which has been created to study, monitor and regulate Peru's fisheries. The Fisheries Program might consider such an institution for future collaboration.

5.2 **In view of the strong support of the Government of Jamaica in the Jamaican project,** we recommend that the Fisheries Program consider further support for the project should the recipient request further phases of funding support. **The achievements of the project to date have to be commended.**

To: Sing Chew

Date: 4 October 1985

From: Brian Davy

Subj: **Mollusc Culture Evaluation Report**

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Overall, most of us feel that this is a very useful document for the Fisheries Program. For the record, I enclose a list of the major and minor specific comments from all of us. Much of this information has already been given to you verbally in our various discussions as well as through memos by each of us.

I wonder if some of our general comments given here can be used as part of the final report. For instance, you may be interested to know that many of the recommendations have already been acted upon (eg. greater emphasis on pre-project training); in fact a number of recommendations have been the subject of discussion before this review was undertaken based on our own monitoring of these projects. As a whole, greater discussion with the recipient on the objectives of the project and their capability to undertake the proposed research plus the specific type of product to be produced and its likely market potential are being implemented.

We are still proposing continued support for mollusc culture research as we continue to see this as an important option for benefitting coastal people in many developing countries. New projects plus Phase II's and III's are being proposed to continue the necessary research and to carry some of the earlier efforts into an operational research and development phase. One new project [Oysterculture (Gambia)], either this FY or next depending on the Fisheries Program budget allocation is being considered with these specific recommendations in mind.

Also our program has recommended in our recent Program of Work and Budget, funding for projects where the product is more of a cash crop for local sale or more commonly for export rather than strictly as a low local sale or more commonly for export rather than strictly as a low priced item for the rural poor. We see this as an evolution in our project support based on results to date. As long as a benefit to a rural fish farmer can be shown, we are willing to consider such support.

IDRC staff inputs continue to be a constraint as our program staff numbers are frozen for the moment. We have therefore taken a different approach to overcome the limited IDRC staff input and to assist in greater coordination and interaction between these projects. We are now using one person, Dr. G. Newkirk, as a part-time network coordinator to all our mollusc culture projects on a contractual basis. In time, we hope that this role can be taken over by LDC staff in each region.

With the creation of a separate Agriculture Economics Program within AFNS, we hope to have a more preproject as well as in-project economic support for detailed economics analyses in these projects. On the recipient side, we continue to face problems in finding suitable economists to do this work in-country but a variety of approaches are being attempted to overcome this problem. These including training biologists in simple cost-benefit analyses, training more economists in ministries or universities where the biological research is being undertaken, contractual hiring of outside economists and trying to hire a regional economics coordinator (Asia) to work with the biologists. Your points on early economic input are well taken. However, we have cases where too early input caused greater confusion than assistance.

I think one point you mention requires further elaboration and emphasis. This is the cautionary note on expectations given by our original consultant Dr. D.B. Quayle. He has repeatedly advised that we must take a much longer term view on the probability of our research support improving or in most cases establishing a tropical mollusc culture industry in the concerned countries. Ten or more years of support is not too long a period of likely needed input. There is no such thing as an "instant oyster industry". If, IDRC wants to see implementation of research results, we should be increasingly prepared to continue our support for such time periods. Therefore, I believe that a case can be made for a later judgment on the successful uptake of mollusc culture in countries such as Sudan, Peru and perhaps Malaysia (Sabah) and Sierra Leone.

One other point that I suggest we examine are mechanisms for making more of the information gained in this study, more widely available. It may be useful to try to publish parts of the study.

Finally, I want to complement you for your time commitment in carrying out this study and your positive interactive approach in working with the recipients and Fisheries Program staff. I believe it was well worth the effort.

Specific Comments

I am concerned that future readers of this report understand that most of the recommendations and conclusions of this evaluation were developed in conjunction with the recipients and especially IDRC Fisheries Program staff. This review should not be seen as an outside and independent evaluation by OPE but rather a joint undertaking in which recommendations came from both sides and are recorded here for future reference. For this reason, many points have already been implemented and are listed here more for "IDRC corporate memory" purposes. I believe this recording of views by itself has been very useful, as well as the more important opportunity this evaluation gave us for a detailed joint examination of the issues.

It should be noted that some factors pointed to in the evaluation are beyond the control of the recipient and/or Fisheries Program and point to an evolution in IDRC thinking.

For instance :

- (1) We are concerned that too great an emphasis was given to the wording of the specific objectives in early projects. IDRC's policy as well as the AFNS Division policy on the level of detail in the objectives and even the inclusion of the training of staff as a written rather than an implied objective were all changes that took place since many of the early mollusc culture project objectives were written. In addition, a more realistic timing (i.e. a longer duration) for the achievement of project results has developed after initial project experiences. Table 3 (page 23) is thus liable to be misinterpreted and could be eliminated.
- (2) Greater priority and probability of IDRC support for development style project or implementation of project research results has been given only in more recent years.
- (3) Preproject training only becomes an explicit IDRC option after the initiation of several of these projects.
- (4) The quality of researcher training that was possible has improved considerably from the time of the earlier projects. Much of this has been due to the initiation of specific FAD funded training projects in Canada and some regions. (eg. Asia and Latin America).
- (5) Technology development of small hatchery techniques in recent years has encouraged us to develop a COOP Program project in Jamaica as an initial attempt to overcome the seed supply problem. Greater efforts will be given in preproject formulation to examination of the potential seed supply problems and concurrently the development of small scale hatcheries as an option to solve such problems.
- (6) Although one can discuss optimum or preferred approaches to successful attainment of objectives, as you are aware, we usually are working under far less than optimum conditions of staff and other recipient infrastructure and support. We are thus left with very difficult choices in recommending or not recommending project support in such cases. We are thus increasingly examining these choices in a more critical fashion than in the earliest days of IDRC.
- (7) Major changes in IDRC F1 program staff and project consultants have taken place in the period of this evaluation.

- (8) Your points on networking are well taken but we feel that region specific networks are more efficient than global networks in meeting IDRC objectives. We have yet to develop enough projects in one region to make this concept fully feasible.
- (9) As always such an evaluation over six different projects, leads to a number of generalizations that cover-up the situation specific issues that develop in specific project development. We hope that it is recognized that this report will be used with this in mind.
- (10) There are a variety of minor points and items regarding emphases which we might question and I list some of these points for the record below. Most other recommendations are being implemented or taken into consideration in defining further IDRC support.

Minor Points of Clarification Include:

- (a) Project staff listings in Table 1 (page 19) are only at the beginning of the project. As mentioned, later in the report, there were often significant personnel changes during the operation of the project.
- (b) The recommendation for further market studies is good. What is not clear, however, is the decision making criteria IDRC might use in deciding support for a project where the local market is limited. Please bear in mind that this limitation is relative and in this case based on comparison with larger scale markets. Local demand for mussels or oysters sufficient to supply income/employment for 10-20 families in a country may seem too small to merit IDRC support. However, where do we draw the line? We have yet to develop clear cut answers to such questions although we are now attempting to do so.
- (c) The report neglects to mention the issue of a necessary legal structure enabling parties to have "ownership" of mollusc culture facilities in common property coastal areas. This could be a serious constraint to technology uptake.

1.0 INTRODUCTION

Molluscs such as oysters, mussels and clams can be found growing in both temperate and tropical waters. As a source of food in terms of much needed protein for the rural poor, its potential increases with the introduction of suspended or off-bottom culturing techniques. Since 1973, IDRC has funded 13 projects on mollusc culture research. Geographically, the Centre's support for this research has been in those regions of the world where the Centre operates : Africa, Asia, Latin America and the Caribbean. In June 1983, six of these projects were identified for evaluation at the request of the Associate Director of the Fisheries Program of the Centre's Agriculture, Food and Nutrition Sciences Division (AFNS). Centre funding for these projects was provided primarily to conduct research on the growth conditions of molluscs in suitable tropical waters and to train scientific and technical personnel to undertake these research tasks. It was envisaged also that from these studies, viable mollusc culture systems of food production for the rural poor could be developed and transferred, and thus funding was allocated for the development of production systems with the view of engendering effective training, processing and marketing activities.

1.1 Evaluation Focus

The general objective was to **evaluate six mollusc culture projects funded by IDRC, and to provide suggestions for future program orientations and areas of support.**

Within this broad objective, the specific objectives were:

- i) to evaluate and compare the origins and rationale of the projects with the funding objectives of IDRC and the Centre's response to these funding requests.
- ii) to evaluate the attainment of project objectives.
- iii) to evaluate whether institutional linkages and research capabilities were strengthened as a result of project activity.

- iv) to evaluate the economic viability of the production systems developed in light of the costs and market demands for molluscs.
- v) to recommend future areas of program orientation and support.

These specific objectives were translated into specific key areas for evaluation, and questions were developed to provide information on these key areas.

The key areas determined for evaluation and the issues/questions posed were:

1) The Origins and Rationale of the Projects

For this area, the questions and issues to be evaluated were:

- a) How did the objectives of the six projects relate to IDRC's funding objectives?
- b) What were IDRC's responses to the requests for project funding from the recipients? What was the nature and expectations of each recipient's request? Were there any changes made to the research proposals?

2) The Objectives of the Projects and Outcomes

A series of questions in this area were of interest to the user:

i) Research

- a) What were the research results of the projects in comparison to the objectives stated in the project summaries?
- b) Were the original objectives of each project realistic and were the objectives changed during the implementation of the projects? If there were changes, what were the reasons for these changes?

ii) Training

- a) Did the training provided improve the technical expertise of the project staff and was the quality of research undertaken for the projects enhanced?
- b) Besides the biological aspects of the training provided, should the project staff be trained in other areas such as socio-economic analysis, marketing and extension services?
- c) Was the training and extension programme to generate adoption of the mollusc culture production technique successful in the local communities and regions where the projects were located? Due to this training and extension efforts, was there a greater awareness of these culture techniques in the country or region in which the projects were located?

iii) Research Capability and Linkages

Under this area, questions of interest to the user were:

- a) Did the projects enhance the scientific and research management capabilities of the staff of the recipient institutions?
- b) Were there any linkages established or strengthened between the staff of the recipient institutions and other staff and institutions in the country or region?
- c) Did the use of consultants increase the quality of research and research capabilities of project staff?

iv) Production

Information of interest to the user in this area were:

- (i) What were the results of trying to establish a production system suitable for transfer to interested parties?
- (ii) What were the costs of production systems developed to culture molluscs in relation to the yields? Provide quantitative and qualitative analysis of market opportunities for distributing the produced molluscs locally and for export.
- (iii) What were the commitments and support of the governments to this phase of the projects' objective? Suggest reasons if there was a drop in governmental support.

- (iv) What are the benefits and disadvantages of having the projects undertaken by universities instead of governmental ministries?
- (v) Is there any linkage between the production system developed by the projects and the activities undertaken by the private sector in the production of molluscs? What is the private sector's perceptions of these production systems?

In addition to these evaluation issues and questions, the evaluation was also to provide suggestions for future program orientations. Basically, of interest to the user are two main questions:

- a) What is the possibility of organizing these projects into a global or a regional network? What are the positive and negative aspects of such a linkage?
- b) What are the future areas of support in mollusc culture research and training?

The above evaluation objectives and the associated questions/issues were developed during a series of meetings with the main user of the study, the Associate Director of the Fisheries Program. An initial meeting was held with the Associate Director to map out the scope of the study. A subsequent meeting was held following the distribution of some preliminary notes, "precursor to terms of reference", to orient the meeting's discussion and to work out the objectives of the evaluation.* From this meeting, terms of reference were drafted and circulated to the Associate Director and the Director of the Division for their comments. Following receipt of these comments, the terms of reference were finalized and an evaluation study was designed to answer specifically the objectives of the evaluation generated from the discussion and meetings.

* Since the start of this evaluation, the Office of Planning & Evaluation has introduced a set of evaluation procedures for evaluation activities of IDRC. This stage of the evaluation is termed as the evaluation assessment phase.

1.2 Methodology

To date, 13 projects on mollusc culture research have been funded by the Centre. The choice of projects for evaluation was based on three criteria so as to ensure that the projects selected would provide the information on the evaluation issues identified. Firstly, each of the 13 projects were considered in terms of their completion status. Preference was given to completed or about to be completed projects to ensure that information on the evaluation issues such as attainment of research objectives, training, capability building and linkages is available and could be evaluated. Secondly, consideration was given to the geographical regions of the world in which the projects were located. This criterion was used to ensure that projects located in varied environmental and socio-political conditions were included in the evaluation to provide a comparative dimension for the evaluation and to allow for the possibility that occurrences in projects are not particular to each project but are typical of the nature of mollusc culture projects funded by the Centre. Thirdly, preference was also given to projects which share common elements in project objectives in order to ensure that the information collected can be compared and generalized.

The methodological tools chosen for this evaluation were comprised of file reviews, semi-structured interviews (ANNEX 1), and economic costs analyses. Project visits were made for qualitative observation and to interview the respective project personnel. For the final analysis, the information obtained from the above methodologies was triangulated to arrive at some of the conclusions made in this study.

2.0 THE PROJECTS

Six projects were identified for evaluation utilizing these criteria. Two projects from each region of the world were chosen. These projects were:

Project Title	Duration	Geographic Region	Centre Contrib. CAD	Recipient Contrib. CAD
1. Oysterculture (Jamaica)				
3-P-76-0057 Phase 1	3 years	Latin America and Caribbean	\$198,100	\$202,000
3-P-82-0022 Phase 2	3 years		\$199,000	\$608,123
2. Mariculture (Peru)	3 years	Latin America and Caribbean	\$212,800	\$139,550
3. Oysterculture (Sabah)	3 years	Asia	\$105,600	\$190,000
3-P-74-0113				
4. Musselculture (Singapore)	3 years	Asia	\$128,740	\$1,393,476
3-P-77-0121				
5. Oysterculture (Sierra Leone)				
3-P-73-008 Phase 1	2½ years	Africa	\$164,500	\$54,560
3-P-77-0146 Phase 2	3 years		\$157,300	\$302,000
6. Oysterculture (Sudan)				
3-P-77-0021	3 years	Africa	\$231,500	\$1,167,410
		Sub-total	\$1,397,540	\$4,057,119
		TOTAL	\$5,454,659	

Total Centre funding (approved) for the six projects was \$1,397,540. This represents 10% of the Centre's fisheries program funding from FY 1970/71 - 1983/84. The recipients' total contributions to these projects were \$4,057,119. In comparison to the Centre's funding, the recipients' contributions were almost three times as much as the Centre's.

The overall objective for the six projects can be summarized as follows:

To undertake scientific studies on the culturing of molluscs and to train scientific/technical personnel with the aim of increasing the production of molluscs for food* in the regions where the projects are located. Included in this overall objective is the development of a viable production technology for transfer, and through training, provide economic opportunities for the people in the country or region where the projects are located.

Each of the six projects identified for evaluation had specific project objectives. An overall commonality of objectives among these six projects enables a summary of these specific objectives:

Specific Objectives of the Projects

- A. Research:** a) To conduct research on various biological aspects of mollusc culture, such as growth condition factors, and spat-fall. Included in this objective are research activities to determine the environmental parameters for identification of suitable areas for spat collection and grow-out phases of mollusc culture, and the collection of statistical data to assess available stock. [Singapore, Sabah, Peru, Sierra Leone I, Jamaica]
- b) To develop a culture system which is the most suitable for the country or region in which the project is located with a view of improving the production and reducing/eliminating the mortality of molluscs, and to determine alternative techniques of production at different locations. [Singapore, Sabah, Peru, Sierra Leone I + II, Jamaica, Sudan]

* This basic objective applies to all the projects identified for evaluation with the exception of the project in Sudan, which was to produce oyster shells as raw materials for other consumer purposes. However the objectives of the Sudanese project in terms of research activities were similar to the other projects.

- B. Applied/Adaptive Research:**
- a) (i) To develop a production system including sanitation, handling, storage, processing and market development suitable for transfer to interested parties. (Singapore, Sabah, Sierra Leone I + II, Jamaica, Peru, Sudan)
 - (ii) To determine the technical and economic viability of alternative production systems. [Sudan, Jamaica, Peru, Sabah, Singapore, Sierra Leone Phase II]
 - b) To establish regulatory measures for the mollusc culture production in the country where the project is implemented. [Sabah]
 - c) To establish a seed supply station. [Sabah]
 - d) To assess the impact of pilot scale mollusc culture operations at selected project sites with particular emphasis on their profitability. [Sierra Leone II]
- C. Training:**
- a) To train local scientific/technical personnel to undertake mollusc culture research. [Sabah, Sudan, Sierra Leone I + II, Peru, Jamaica, Singapore]
 - b) To train the local community to undertake mollusc culture production techniques. [Sierra Leone I + II, Peru, Sudan, Sabah, Jamaica, Singapore]
- D. Dissemination:**
- a) To undertake an extension and demonstration programme including publications, and seminars aimed to inform research personnel and local communities of mollusc culture research and production techniques. [Singapore, Sierra Leone I + II, Peru, Sabah, Jamaica, Sudan]

Reviewing the project summaries and project files, the main rationale for funding these projects was for the **production of food** (with the exception of the project in Sudan which was aimed to increase the economic livelihood of fishermen living in the area where the project was located). The possibility that the developed production system of culturing molluscs would provide economic opportunities for rural fishermen was also considered. With this funding rationale,

the first project located in Sierra Leone was approved by the IDRC Board on September 20, 1973. It was the first mollusc culture project funded by the Centre. This was followed by projects in Sabah and Jamaica in 1975 and 1976. These three projects formed the kernel of IDRC's project funding to mollusc culture research and served as guides for future project activities in this area. Throughout the 1970's, the Centre continued to fund projects in mollusc culture research. The other three projects identified for evaluation [Musselculture (Singapore), Oysterculture (Sudan), Mariculture (Peru)], were funded subsequently between 1977 and 1979 (See Annex 2 for brief summaries of the 6 projects).

3.0 ISSUES OF THE EVALUATION

This chapter reports on the evaluation of the identified components of the mollusc culture projects' activities. The discussion focusses on the issues and questions identified for evaluation:

- a) Origins and Rationale of Projects
- b) Objectives of Projects and Outcomes.

A discussion on future areas of program orientation and support concludes the chapter.

3.1 Origins and Rationale of Projects

Two of IDRC's corporate objectives as outlined in its Parliamentary Act tasked the Centre to fund projects in the Third World to produce scientific knowledge for development and to develop the research capacity and capabilities in the Third World. If we review the overall funding objective of the six projects (See Page 7), one can derive that the aim was to produce useful knowledge for development and to build up research capacity. Specifically, the six projects were to conduct research on the culturing of molluscs in suitable tropical waters and to train scientific and technical personnel to undertake these research tasks. From these research activities it was envisaged that viable mollusc culture systems of food production for the rural poor could be developed. Therefore funding was allocated for the development of a production system with the view of establishing an effective training, production, processing, and marketing program. Inspection of approved project summaries, file reviews and interviews with program staff indicate that **emphasis was placed on conducting biological research on the culturing of oysters, rather than on the building of research capability aspect of the projects' activities** (the training of scientific/technical personnel and the provision of study tours). The latter was included to facilitate the achievement of producing utilizable research results for transfer to interested parties. Therefore, the latter activity was not the goal of the six projects but rather the **means** to achieve the goal of producing useful scientific information for development.

If we further examine the range of activities of the six projects, the rationale for funding these projects clearly underscored IDRC's mandate and mission. Project objectives included the development of a production technology suitable for transfer to the rural fishermen. The overall aim, therefore, is to increase the livelihood of the rural people through an increased production of protein and the provision of economic opportunities. The targeted beneficiaries of these six projects being the rural poor, corresponded closely to the operating policy of the Centre as expressed by the then President of IDRC, Dr. David Hopper at the Inaugural Meeting of the Board of Governors of the Centre (October 26, 1970 :4):

"I would suggest that we select now a programme stress that seeks to promote the welfare of peoples both farm and non-farm living in rural areas throughout the world. This would provide a broad umbrella under which the Centre's staff would select and develop worthy projects for consideration over the next few years. It would prove possible to build a total programme of interlocking activities that would, in time, form the ribs of the umbrella onto which could be sewn the fabric of world advance"

In summary, therefore, the projects' objectives (without relating to the specifics of each project's objectives) and rationale were in line with the funding objectives of IDRC in terms of aims and beneficiaries. This analysis relies on our reviews of project summaries and files, and on interviews with IDRC program staff. It is therefore a perspective from IDRC's point of view and funding intention.

We also explored this issue of the projects' objectives and rationale with IDRC project leaders and senior administrative personnel associated with the projects. We were interested in obtaining their views on what they intended to achieve through the activities of the projects. The responses from the interviews with project leaders and administrative personnel reveal that achieving **socio-economic development**, and **solving a scientific issue/problem identified by the ministry/university** were paramount concerns.

The priority (descending order) placed by all the project leaders and administrative personnel on what they intended to achieve from the projects is as follows:

- 1) Achieve socio-economic development - solve a scientific issue/problem;
- 2) Fulfill departmental plans;
- 3) Increase food production;
- 4) Develop scientific capabilities.

Solving a scientific issue/problem as an objective was in line with IDRC's funding objective for these projects. The other priority of achieving socio-economic development however needs to be clarified. All project leaders viewed the projects as providing economic opportunities for segments of the population in the countries where the projects are located. As well, due to high production costs and lack of market demand for molluscs in the countries where the projects were located, some recipients (Singapore, Jamaica) tended to place emphasis on the production of molluscs as a cash "crop" rather than as a food "crop" as envisaged by IDRC program staff. Because of this, two of the recipients (Jamaica and Singapore) and IDRC staff had differed slightly in terms of project directions. In the Jamaican case, file reviews and discussion with project personnel suggested that Centre staff encouraged the recipient in the first phase of the project to direct project activities for a product suitable for the consumption of the rural poor; whereas the recipient felt that the demand of the product, due to production costs, would be more suitable for the local tourist hotel trade. [This difference is not evident in Phase II of this project. There are no indications that the Centre program staff is continuing to insist on the production of the molluscs as food for the rural poor.] This 'cash crop' emphasis is most pronounced in the case of the Singapore project where it is clear from a project visit that the cost of production, the sophisticated level of production technology, and the administration of suitable sized culture sites can only be borne by non-artisinal fishermen.

Besides this review of the objectives of the projects vis-à-vis IDRC's funding objectives, we also examined IDRC's response to the requests for project funding. Our review of project files indicate that all requests, with the exception of the Peruvian project, were reviewed promptly by Centre staff. In the case of the Peruvian project, the IDRC fisheries program staff delayed a year in responding to the request (See memo : J. Valle-Riestra to B. Allsopp, June 16, 1977; Letter : B. Allsopp to Manuel Vejas-Velez, May 3, 1978). The reason provided was the heavy travel schedule of the program staff.

Even though there was an initial delay in IDRC's response to the Peruvian request, the Peruvian recipient along with the other recipients were unanimous in praising the manner in which IDRC handled the responses to their initial requests.

We also examined other dimensions of the development of the research proposals for funding by IDRC. From IDRC project files, five of the six project proposals (Singapore, Malaysia, Jamaica, Peru and Sudan) were submitted initially by the recipients with IDRC responding to these proposals and in some cases, suggesting changes. Such development of research proposals reflect the IDRC style of operation, whereby the Centre responds to requests from the Third World for funding support.

However, from our file review, the Sierra Leonean Project (Phase I) was stimulated by IDRC program staff responsible for West Africa. The first request for support to conduct oysterculture research in West Africa was an official letter from the Government of Gambia (Nov.20, 1972). The letter requested IDRC's support in the identification and study of the life history of the local oyster, marketing and processing studies, and possible areas in Gambia for cultivation. IDRC's response was a letter from the Associate Director (Fisheries Program AFNS) to the Department of Biology at the University of Sierra Leone (Jan.32, 1973) requesting information on the state of oysterculture research in Gambia, and at the same time, suggesting to the Sierra Leoneans IDRC's interest to support oysterculture research in Sierra Leone, in view of the

limited personnel capabilities in Gambia. This was followed up with a letter to A.G. Sembu-Forna, Minister of Agriculture, Government of Sierra Leone on March 27, 1973, expressing IDRC's interest to support an oysterculture project in Sierra Leone and as well informing the Minister, of Gambia's request which in IDRC's view was weak in terms of research capabilities to support oyster culture research. The intent, therefore, was to develop a project in Sierra Leone with the hope of transferring to Gambia the knowledge produced. With such active stimulation, a project proposal was received from the Government of Sierra Leone.

It should be noted that of the six projects evaluated, only one out of the six projects was, in our view, developed through the active stimulation of IDRC. **Therefore, the development of the projects' proposals, with the exception of one project, did not veer away from IDRC's style and philosophy of operations.**

The other dimension of research proposal development which we reviewed was the research proposal itself. **Of the six research proposals submitted by the recipients, two of the proposals (Sudan and Peru) had changes made to them following review by IDRC personnel.** We compared the original research proposals vis-à-vis projects' objectives with those project proposals submitted for Board approval and found that the Sudanese and Peruvian projects had substantive changes made to them by IDRC program staff. The original research proposal request by the Peruvian recipient was to conduct investigations of molluscs and fishes such as mullets, and yellow tails. Following receipt of this request, the Associate Director of AFNS's fisheries program wrote (May 3, 1978) to the recipient suggesting that it would be feasible for IDRC to fund research on molluscs, but it was not possible on technical grounds for the Centre to support research on the species of fish that was specified in the research proposal. For the Sudanese project, the recipient's original proposal was targeted to research the high mortality rates of the mother of pearl oysters growing in the coastal waters of Sudan. IDRC program staff and consultant counselled the recipient that it would be difficult to investigate the biological

reasons for the high mortality rates that occurred, but it would be feasible for the Centre to support a project investigating the culturing of the mother-of-pearl oysters. Following discussions with IDRC program staff, the Sudanese and Peruvian recipients submitted research proposals along the research themes suggested by the Centre's program staff.

For the remaining four project proposals, we find that there were only cosmetic changes made by IDRC program staff. However, it must also be mentioned that the Malaysian recipient, the Director of Fisheries of the Government of Sabah, voiced during our interview with him, some negative comments concerning the development of the research proposal. According to the Director of Fisheries, he felt that the Centre's program staff's input to the development of the research proposal made the Malaysian project too scientific and technical for the level of expertise of his staff. We cannot find any corroborating evidence of this in our review of the Sabah project's files.

Summary

1. a) The objectives of the six projects reflected the funding objectives of the Centre.

b) There were minor differences between Centre Program staff and two project recipients (Jamaica and Singapore) with respect to the markets for which the molluscs were being cultivated. However, these differences were discussed and settled during Phase I project activities and they were not present for example, in Phase II of the Jamaican project.
2. a) Generally, in the area of the development of project proposals, we find IDRC program staff response to the initial requests to be reflective of the style and operating philosophy of the Centre. However, there was active stimulation on the part of IDRC program staff to develop the project in Sierra Leone. A delay of one

year in terms of responding to recipient request occurred during the development of the project in Peru. The busy travel schedules of program staff were given as reasons for the delay.

- b) There were also substantive changes made to the research proposals of two projects (Peru and Sudan). The changes made by IDRC program staff narrowed the scope of the proposed research, and in our view, structured the projects into a more manageable set of research activities.

3.2 THE OBJECTIVES OF THE PROJECTS AND OUTCOMES

3.2.1 Research

Human Resource and Institutional Capacities

In examining the specific research objectives of the six projects and the attainment of these objectives, one has to evaluate these issues within the context of the research capacities in oysterculture research of the countries where the projects were located. The different countries in which the projects were funded had varying levels of research capacities to support oysterculture research. As far as we can determine from file and literature reviews and interviews with project leaders, none of the countries (with perhaps the exception of Singapore) had an ongoing mollusc culture research program before the inception of the IDRC projects. This does not mean, however, that there were no research or practical activities on biological studies of the oyster in these countries prior to the start of the projects. Five of the countries (Singapore, Jamaica, Sudan, Malaysia, Peru) in which the projects were located had undertaken some technical studies on the growth and culture of oysters. There was, however, no indication of an active effort to mount a research program to culture oysters.* Singapore is the only country which seemed to have expended some effort in conducting musselculture research. Prior to the start of the project, there were some preliminary research studies on the culturing of mussels in Singapore; for example, a paper was prepared entitled "Preliminary Observations of Mussel Culture" for an ASEAN conference in Singapore by a staff member of the Department of Primary Production, Government of Singapore, who later became the IDRC project leader. Biological research on mussels was also undertaken at the University of Singapore.

* Regionally, for example, in Asia, a consultative mission on Asian aquaculture research undertaken in 1978 listed only a regional institution SEAFDEC as having the infrastructure to undertake work on bivalves research, and according to the mission it was at that time a minor priority of the Aquaculture Department of SEAFDEC. Research Reinforcement in Aquaculture for Countries of South and South East Asia 21 April 1978, IDRC. Vancouver.

For Sudan, initial studies on the cultivation of the Mother of Pearl oysters were undertaken by foreign expatriates during the late 1950s to early 1960s. However, this history of some initial studies being carried out in Sudan does not mean that there were research capabilities to undertake research on oysterculture. The training that had to be provided at pre-project and during the course of the project indicated otherwise. In Jamaica, as well, prior to the start of the project, some biological studies had been performed on the oyster at the University of West Indies. Also the Fisheries Division of the Government of Jamaica had conducted some preliminary technical studies on the collection of spat. The Malaysian case was much different. "Technical" experiments were undertaken to investigate whether oysters could be cultured in the coastal waters of Sabah. But, according to the Director of Fisheries, these experiments were not scientifically based and funds were allotted to a fisheries officer to undertake basic trials. For Peru, biological laboratory research was conducted prior to the start of the project, though not by the project recipient.

This review of the conditions in the five countries leads us to conclude that, **with perhaps the exception of Singapore, there were no ongoing research programs on mollusc culture in the countries where the projects were located prior to the inception of the projects.** Such an absence would suggest therefore that research experiences to conduct mollusc culture research would be lacking and thus the capability to conduct the project research objectives would not be as promising. But the absence of a research program **does not necessarily mean** that project recipients would have difficulty in mounting research programs in mollusc culture, because prior research experience in mollusc culture is not the only condition reflective of research capacity.

The research capabilities of project personnel to conduct biological research is another dimension to consider along with the institutional-infrastructure capacity to undertake the proposed research. An indicator would be the level of training the project leader and technical personnel had prior to the start of the projects.

Table 1 shows the level of training of the project leaders and technical personnel of the IDRC projects.

TABLE 1
PROJECT PERSONNEL and LEVEL OF TRAINING

Project Personnel	Level of Training
<u>Oysterculture (Jamaica)</u>	
Project Leader (1st)	Ph.D. (Zoology)
Project Leader (2nd)	B.Sc. (Marine Biology)
Scientific Personnel (x1)	Ph.D. (Zoology)
Scientific Personnel (x2)	B.Sc. (Biology)
<u>Mussel Culture (Singapore)</u>	
Project Leader (1st)	B.Sc. (Hons.)
Project Leader (2nd)	B.Sc. (Hons.) (Biology)
Scientific Personnel (x1)	Ph.D. (Microbiology)
Scientific Personnel (x2)	B.Sc. (Biology)
<u>Oysterculture (Malaysia)</u>	
Project Leader	B.Sc. (Biology)
<u>Oysterculture (Sierra Leone)</u>	
Project Leader	M.Sc. (Marine Biology)
Expatriate Consultant	B.Sc. (Biology)
Scientific Personnel (x4)	B.Sc. (Biology + Botany)
<u>Oysterculture (Sudan)</u>	
Project Leader (1st)	M.Sc.
Project Leader (2nd)	M.Sc. (Limnology)
Scientific Personnel (x3)	B.Sc. (Biology)
<u>Mariculture (Peru)</u>	
Project Leader	B.Sc. (Animal husbandry +Pisciculture)
Scientific Personnel (x3)	M.Sc. (Biology)
	B.Sc. (Biology) x 2

The level of formal training attained by project personnel should not be construed as a necessary threshold for an individual to be capable of undertaking mollusc culture research. Years of practical experience acquired through work settings in the specific field, as in the case of the first project leader in Singapore, would just be as important. Notwithstanding this, however, the level of formal training

attained in the specific field would be a rough guide as to the ability of the individual to undertake mollusc culture research. In light of this information and from discussion with the IDRC consultant, **the projects' personnel research capabilities to undertake mollusc culture research were uneven. According to the IDRC consultant, Sierra Leone, Jamaica and Singapore were well trained to conduct biological research, whereas Malaysia, Sudan and Peru were much weaker in this regard. This condition was alleviated with the provision of pre-project training.**

Analysis of the institutional-infrastructure capacity to undertake mollusc culture research is a difficult dimension to evaluate. Firstly, our project visits occurred long after the projects had commenced and therefore it was difficult to provide information on this area. A rough indicator for this would be the availability of resources for the projects such as support staff, material and transport commitments provided by the recipient as a contribution to the projects. All the projects required IDRC to fund research equipment and transportation for the research activities. **This suggests that IDRC had to strengthen some aspects of the research infrastructure.** In the area of human resources, the number of project personnel made available to undertake research activities would indicate some level of infrastructure support existing in the recipient institution and the commitment on the part of the host government. Of the six projects, **only one of the projects (Peru) received funds from IDRC as salary support to project personnel.** Table 2 provides a breakdown of the human resource commitments to the six projects.

TABLE 2: HUMAN RESOURCE COMMITMENTS OF PROJECTS

<u>Project</u>	<u>Number and Type of Personnel</u>
1) Sierra Leone Phase 1	1 Project Leader 1 Expatriate Consultant 3 Research Assistants 1 Processing Officer 20 Field Staff <u>26</u>
2) Jamaica	1 Project Leader 2 Associates 2 Extension Officers 1 Technical Assistant 18 Support Staff <u>24</u>
3) Singapore	1 Project Leader 3 Associates 2 Technicians 2 Research Assistants 4 Administrative Staff 12 Field Assistants <u>24</u>
4) Sudan	1 Project Leader 4 Associates 4 Technicians 12 Assistants <u>21</u>
5) Malaysia	1 Project Leader 3 Associates 1 Fishery Assistant 8 Support Staff <u>13</u>
6) Sierra Leone Phase II	4 Fishery Officers 2 Technical Assistants 4 Field Assistants <u>10</u>
7) Peru	1 Project Leader 1 Research Associate 1 Engineer Technician 3 Field Assistants 3 Faculty Members (Visiting) <u>9</u> (4 persons at project site full time)

* Human resource commitments were determined during project visits, discussion with project leaders and review of progress reports and final reports. In certain cases the numbers might be misleading, especially for the administrative staff, as recipients would include them even though mollusc culture activities might not be the sole work activity occupying the staff.

From Table 2, the **available human resources for the projects clearly vary**. Five of the projects had thirteen or more staff members committed to the projects. With the exception of the Peruvian project which had the lowest number of human resource commitment, the other five projects were better endowed with project personnel.

The above conditions which we have discussed, i.e. prior research experience in mollusc culture research, research capabilities of the project personnel and the institutional-infrastructure research capacity do affect the progress and attainment of the projects' objectives, albeit there are other factors to be considered.

Attainment of Project Objectives

All the projects evaluated did not reach all the stated objectives. There were only partial attainments of specific objectives in each case. This is confirmed by both file analysis and interviews with project leaders who were frank with regards to the attainment of specific objectives. Table 3 lists the number of specific objectives listed in the project summaries of the projects and the number of objectives attained.

TABLE 3
NUMBER OF PROJECT OBJECTIVES ATTAINED BY THE PROJECTS

Project	Number of Project Objectives Listed in Project Summary	Number of Project Objectives Attained (Project Leader Assessment)
1) Mussel culture (Singapore)	5	3 (Attained) 2 (Partially Attained)
2) Oysterculture (Jamaica)	2	2 (Partially Attained)
3) Oysterculture (Malaysia)	6	3 (Attained) 3 (Partially Attained)
4) Oysterculture (Sierra Leone)		
Phase 1	4	4 (Attained)
Phase 2	4	1 (Attained) 3 (Partially Attained)
5) Mariculture (Peru)	4	3 (Attained) 1 (Not attempted)
6) Oysterculture (Sudan)	4	3 (Attained) 1 (Not attempted)

The information provided in Table 3 regarding the attainment of project objectives was derived from interviews with project leaders. The number of project objectives attained were from the recipients' point of view. It was difficult from file analysis, considering the limited amount of information available in the files, to come to an assessment of how accurate and valid this information was in terms of attainment of project objectives. Also, it does not reflect the quality of work undertaken to reach the objectives nor the conclusiveness of the research findings. Consultant technical evaluations of the projects' progress often suggest that further analyses should have been made of

the research activities and the inconclusiveness of the findings in several areas of research. These comments apply to projects in Malaysia, Sudan, Jamaica, Sierra Leone and Sudan. The technical comments made by the consultant vis-à-vis the inconclusiveness of the findings are directed to the biological studies of oysters and the variety of techniques used to evaluate a suitable system for oysterculture. **The inconclusiveness of some of the findings was attributed in the consultants' reports to the lack of persistence in continuing biological trials and experimenting with different culture techniques, and also the lack of an attempt, in cases, to correlate different experimental trials.** For example, we provide an excerpt from one of the consultant's reports to exemplify what we are discussing:

"It was found that (name deleted) had conducted a small test of the stake culture technique, a fact not previously reported or communicated. He did not pursue the investigation because of unexplained mortalities. This lack of persistence (sic) has eliminated promising techniques in a number of projects"

(Consultant's Report on Oysterculture (Malaysia)
3 March 1982)

These concerns are also shared by IDRC program staff. In reviewing oysterculture (Sierra Leone Phase II), the IDRC program staff listed areas which had to be tackled three years following project start.

"Problem Areas

2) Methods of Culture and adequacy of testing the systems:

cultch and seed collection systems;
strings or wires/availability and costs;
rafts - construction - efficiency, life costs;
racks or frames (limited tests and omissions);
other methods of culture (see 10a - objectives)"

(Summary of Project, Oysterculture (Sierra Leone)
Phase II, February 17, 1982, Page 1)

Generally, in terms of attainment of the specific projects' objectives, the six projects made progress in the areas of biological research on the growth characteristics of the molluscs, the culturing of molluscs through experimentation with various techniques, and in the area of training, albeit some of the research results obtained might be inconclusive and the attainment of specific objectives uneven among the six projects. **The area of the specific projects' objectives which was stalled (with the exception of Jamaica, Singapore and Malaysia) is the successful dissemination, transfer and pick-up of the developed production techniques to prospective farmers.**

According to the project recipients there are several factors for the partial attainment of project objectives. Three general reasons are cited by several recipients:

- 1) Staff departures (permanent and temporary) from projects (Jamaica, Malaysia, Sudan);
- 2) Lack of continuous local Government support (Malaysia, Sierra Leone Phase II);
- 3) Weak capabilities (research or extension) to undertake project activities (Sierra Leone Phase II, Sudan).

In addition to the reasons listed above, environmental conditions were also cited by two project recipients (Malaysia, Peru) as affecting the progress of the projects. In the Malaysian project, excessive lumbering of the surrounding areas at the project sites which included a commercial oyster farm, led to excessive silting of the rivers. Due to this, it was believed that the pH of the river water had changed drastically leading to high mortality of the growing oysters in a commercial farm (which was at the point of generating interest in oysterculture in the area) utilizing the developed culture system of the project.

The Peruvian project's timing of research activities experienced a set back when the phenomenon known as El Nino caused a drastic change in the water temperatures of Peru's coastal areas (October 1982-July 1983). Mortalities occurred in one of the species (Aulacomya ater) on

which biological studies were to be conducted and this therefore affected the progress of the project. (Furthermore, there were also other specific reasons given by the Peruvian recipient as factors for the non-attainment of project objectives. We reviewed these specific factors by consulting both project files and Centre personnel. We found that the specific reasons provided by the Peruvian recipient cannot be justified. See memo : S. Chew to Ramon Buzeta 7/2/84).

We reviewed the project files vis-à-vis the factors given by project recipients for not attaining certain specific research objectives:

Staff Departures: Permanent staff departures were evident in the Jamaican and Malaysian projects. In the Jamaican case, the project leader left the project towards the end of the first phase. The project personnel who was sent for pre-project training did not return to the project following completion of training. It took almost a year before the post doctoral fellow's position assigned to the project was filled. Clearly, therefore, the lack of trained personnel to undertake project activities would hamper the progress towards attainment of project objectives. Notwithstanding this, the rest of the project staff (4) remained through the project. In this regard, there is a level of continuity of staff as compared to the project in Malaysia.

The Malaysian project exhibited a high staff turnover. Although the project leader remained with the project until almost its completion, the staff members (3) who were assigned to the project and who went for training or orientation tours **were not assigned to undertake project activities following the completion of these training tours.** In the Sudan project, the technical staff assigned to the project had to leave for temporary M.Sc. training abroad and this disrupted some aspects of project activities.

Lack of continuous local government support: Two project recipients, Malaysia and Sierra Leone (Phase II), voiced the lack of continuous local government support as

affecting the projects' progress. File reviews indicate the lack of continuity of government support for the above projects. The project in Malaysia was complicated further with personality conflicts between the project leader and senior administrative personnel in the recipient institution. Deteriorating economic conditions in Sierra Leone contributed further to an incapacity of the Government of Sierra Leone to provide further funding to project activities.

Weak Capabilities (research or extension) to undertake project activities:

Two project recipients (Sudan, Sierra Leone Phase II) indicated that this was a factor in conditioning the progress of attaining all the projects' objectives. Three Sudanese personnel had to be trained at the M.Sc. level to facilitate the research activities. Their temporary absences meant a lack of trained personnel to undertake research activities. Because the recipient institution had not staggered the training for the period of project staff absences, project activities were hampered throughout the first phase of the project.

Weak extension activities were indicated by the recipient for phase II of the Sierra Leonean project. In the project leader's view, his staff had to undertake extension activities (which formed the major facet of phase II) for which the project personnel were not adequately trained. According to him, his staff were research biologists who had to reorient their work from research to extension activities which were different.

Clearly therefore the three factors discussed above, i.e., staff departures, lack of continuous local government support, and weak capabilities to undertake project activities, affected the attainment of the research activities of the project. The absence of an ongoing mollusc culture research program in the countries where the projects were located (with the exception of Singapore) meant undertaking research activities which had not been performed before, thus adding to a higher chance of setbacks in research. The project staff in Peru, Sudan and Malaysia were not as well trained for mollusc culture research and this affected the progress of the research activities. Furthermore,

we find that the projects which had experienced difficulties were ones which had low commitments of human resources: Malaysia (13), Sierra Leone Phase II (10), and Peru (9). As we have argued before, **the number of personnel committed by the recipient institution can provide an indicator as to the commitment of the recipient to the project and the level of institutional-infrastructure capacities.**

Changes in Project Objectives:

Following the implementation of the projects, changes were made to the objectives of two projects (Jamaica, Peru). The other four projects did not experience any changes in project objectives. A shift in the overall emphasis of producing oysters as low cost protein for the rural poor to producing oysters as a cash crop for sale in the market and local hotel trade was made in the Jamaican project after it had started. The reason provided for this shift rested on two conditions. The first being the high cost of producing these oysters and then as a low cost protein, oysters would not be commercially viable. Secondly, oysters are not included in the daily diet of the Jamaican and thus the domestic market potential was not high. However, with the tourist and hotel trade existing in Jamaica, it was felt by the recipient that the market for the oysters produced would be higher in this area. This change in objective was undertaken by the recipient.

The Peruvian project experienced changes in the species of molluscs to be studied and the emphasis in the research activities to be undertaken. For the former, due to a high mortality rate of mussels (Aulacomya ater) which was attributed to the temperature changes of the water as a result of the El Nino, the recipient shifted its research activities to the study of the scallops. Research activities were also shifted solely towards scientific studies of the scallops instead of undertaking, as well, demonstration and application of the developed culture techniques to the prospective farmers. The reason provided by the recipient for shifting the emphasis of research activities was the amount of time lost during the start of the project. We have examined this issue (Memo S. Chew to R. Buzeta 7/2/84) and found the reason given to be groundless.

Summary

1. a) All projects did not reach the stated objectives of the project summaries. Furthermore, it must also be stated that for the objectives attained, some of the findings might be inconclusive.

b) Reasons for not attaining these objectives are:

i) Research/Extension and Institutional Capacities: In our view, the research and institutional capacities to undertake research activities in mollusc culture were not adequate (with the exception of Singapore) to fulfill these tasks, if we consider that the main emphasis of these projects was to undertake scientific research to produce useful research results. Training was provided to project recipients to upgrade their research capabilities, though this was not the main thrust of these projects.

Permanent and temporary project staff departures further affected this condition.

There was also a lack of trained extension personnel on the project teams (with the exception of Jamaica) even though project objectives included dissemination and transfer of the developed technology.

ii) Lack of Continuous Government Support: The absence of continuous government support affected the progress of the projects in Sierra Leone and Malaysia. The lack of continuity in government support was attributed to economic conditions and in the case of Malaysia, was complicated by personality conflicts.

2. a) In light of the above, the original objectives of the six projects were too ambitious considering that the recipients not only had to produce research results, but as well, to undertake the dissemination and transfer of the developed technology. We are led to ask whether the first phases of the

six projects should have emphasized and concentrated on primarily training and upgrading of the researchers to conduct mollusc culture research with a lesser emphasis on undertaking research activities to produce research results.

- b) Changes in Objectives after Project Implementation: Two projects (Jamaica and Peru) had their objectives changed during the course of project activities. For the Jamaican project, the objective to produce a low cost protein for the rural poor was shifted towards producing a cash crop for sale in the local tourist and hotel trade. Reasons for this shift were the high production costs and the low market demand for oysters by the rural poor in Jamaica. In the case of the Peruvian project the number of species of molluscs to be studied were reduced and the research activities were shifted solely towards scientific studies. The decrease in the number of molluscs studied was accounted for by the changes in environmental conditions but the shift towards concentrating solely on scientific activities appeared to be groundless.

3.2.2 Training

Study Tours, Short Term and Degree Course Training : Results

Of all the project activities targeted for completion, the training of project personnel was an area which was successfully completed. Table 4 shows the number of project personnel trained for each project and the type of training completed.

TABLE 4
PROJECT PERSONNEL TRAINED and TYPE OF TRAINING PROVIDED,
MOLLUSC CULTURE PROJECTS

Project	Number of Personnel	Type of Training	Status
Oysterculture (Jamaica)	1 4 <hr/> 5	Pre-Project Training Short Term Course (8-10 weeks)	Completed "
Mussel Culture (Singapore)	1 1 <hr/> 2	Study Tour Short Term Course	" "
Oysterculture (Malaysia)	1 3 <hr/> 4	Pre-Project Training Study Tour (3 mos.)	" "
Oysterculture (Sierra Leone Phase I)	1	Pre-Project Training	"
(Sierra Leone Phase II)	1 1 <hr/> 4	Bacteriology Training Short Term Course Short Term Course (Dalhousie University)	" " " "
Oysterculture (Peru)	3 2 2 <hr/> 7	Pre-Project Training Study Tour Short Term Course (Dalhousie University)	" " "
Oysterculture (Sudan)	4 3 <hr/> 7	Pre-Project Training M.Sc.	" "
TOTAL			29

The total number of people sent for training on short term courses, study tours and degree courses was 29. As an objective verifiable indicator of achievement in training, all the trainees sent for degree program training successfully completed their degrees. It is very hard to gauge whether those sent on short term courses benefited from their attendance at these training sessions. From the response given by the trainees in interviews, the training they received was valuable and useful to their research activities. Most of the trainees also wished for the period of training to be longer. The responses were uniform and consistent in this regard, even though the trainees had undergone different forms of training such as short term courses, pre-project training and study tours. In terms of the usefulness of the training, project site visits indicated that research and culture techniques shown to the trainees during that short term training were utilized and in fact influenced their research plans.

Different forms of training were provided to project recipients. On the whole, the training provided was specifically geared towards conducting research on the culture of molluscs with the exception of three trainees (Sudan) who undertook graduate degree courses. We found **during project site visits that trainees have adopted the research techniques and methods of mollusc culture research disseminated to them during their training.** However, this does not mean necessarily that the quality of research undertaken by them has been enhanced by the training provided. A fruitful indicator of gauging whether the quality of research has been enhanced would be to examine the technical consultant's report on the progress and evaluation of the scientific studies undertaken by the project recipients. For all the projects (except Singapore), the consultants' reports emphasized: the need to be more persistent in the biological studies and trials, the lack of scrutinisation of results obtained, and the inconclusiveness of some of the scientific findings. Clearly, therefore, the recipients have not matured as researchers to the extent expected by these reports. Two recent technical consultancy reports (Sept. 1984, Oct. 1984) on the projects in Peru and Sudan indicated that the technical expertise of the project recipient had not improved as much as one would expect following

IDRC project training. In the Sudanese case, the consultant commented on the sketchy data and analysis presented. This is a cause for concern, especially when the 3 project personnel were trained at the Masters level with a thesis specialization on molluscs. **Furthermore, the failure to reassign trainees to project activities or the return of trainees to the project following completion of training ensured that the training provided did not achieve the objectives intended.** This occurred in three projects (Sierra Leone Phase I, Malaysia, and Jamaica Phase I). The Malaysian project had a sad record in terms of trainee reassignment to project activities following completion of training. In the case of the Sierra Leone and Jamaican project only 1 trainee each did not return to the project. In the Jamaican case, it affected Phase I of project activities.

Future Training Areas

The training provided to project personnel has focussed on biological studies and techniques of oysterculture research. Project personnel were interviewed with regards to further areas in which the Centre could fund training. Three main areas were identified:

- 1) socio-economic analysis;
- 2) extension activities;
- 3) processing and marketing of oysters.

This identification of the above areas can be attributed to the following: firstly, all the project personnel interviewed were biologists or had educational training in the natural sciences; secondly, expertise in extension activities was not prevalent in the projects with the exception of the Jamaica project; and finally, this lack of knowledge is also evident in the area of processing and marketing of oysters with the exception of the Sierra Leone project which had expertise in this area. Rather than proposing that these are the areas which the Fisheries Program of IDRC should focus on in future for training, **we suggest that consideration be given in future projects for the inclusion of personnel trained in these areas to the project, either on secondment or through direct participation of Ministries which are responsible for these line functions in the countries where the projects are located.**

User Demonstration

The projects' objectives not only required training to be pursued for project personnel, but there was also the objective of demonstrating and training prospective farmers in the culture techniques developed by the projects. The results of this objective was limited to only 4 **projects** (Singapore, Malaysia, Jamaica and Sierra Leone) which had achieved significant results in terms of developing a system of culture which can be adopted by prospective farmers. **The number of farmers adopting the culture process who were shown the technique is not very encouraging.** Table 5 provides the statistics of the number of farmers who were shown the technique and the record of those who adopted the culture process.

TABLE 5

	Number of Farmers Shown the Technique	Number of Farmers Picked Up Technique	Number of Farmers Continuing
Jamaica			
Phase I	13	5	1 (Since 1981)
Phase II	20	11	11 (Since 1982)
	<u>33</u>	<u>16</u>	<u>12</u>
Singapore	28	10	10* (Since 1981)
Malaysia	40	-	-**
Sierra Leone			
Phase I	-***	-	-
Phase II	-	-	-

* Included in this is a large scale commercial farm which was set up, export shipments of 20 tons of mussels (half-shell) to Japan have been made.

** Malaysia had a private commercial farm set up but the farm went bankrupt after a high mortality incident. The individual who owned the farm was not part of the group which was shown the technique.

*** Sierra Leone has given demonstrations to interested farmers, but no records were kept of the number. Project staff indicated that farmers who helped with the research experiments were shown the technique.

As can be seen from Table 5, the rate of successful adoption of the culture technique is uneven. The success of the Jamaican project in having the highest number of adoptions of the developed culture technique can be attributed to several factors. **The most important in this case being the allocation of two full-time extension officers to the project by the Government of Jamaica.** This in our view facilitated the successful transfer of the developed process. **In addition to this provision of full-time extension officers, there was also a greater emphasis in the project to undertake extension activities as compared to the Sierra Leonean project (Phase II) which had a similar 'life-history'.** These factors, along with significant financial support including capital start-up funds for prospective farmers from the Government of Jamaica, and the lack of other viable economic opportunities in the rural areas of Jamaica, facilitated the successful transfer of the developed culture technique.

Other demonstration activities were also undertaken by project personnel of the projects in Sudan, Sierra Leone (Phase II) and Singapore. These included information booths at fairs and farm shows, radio broadcasts and guest lectures at universities and schools near the project sites.

Summary

1. a) The training provided was completed successfully. A total of 29 persons were trained. All trainees sent for degree courses (MSc) completed their program successfully.
- b) Trainees with no background in mollusc culture research were able at the end of the training to have some understanding of mollusc culture research. However, from the technical consultants' reports, the quality of the research undertaken post training indicated that there is room for improvement.

- c) The areas of training suggested by the project recipients have to be considered carefully. In light of the needs of the projects, skills in socio-economic analysis, processing and marketing techniques are required for future project activities. The question is whether training should be provided in these areas to project personnel, or staff with expertise in this area be included in future project teams.
2. a) The dissemination and user demonstration of the developed culture processes were undertaken in only four projects (Jamaica, Singapore, Sierra Leone and Malaysia). The success of the farmers adopting the culture process varied among the projects. The only projects which have exhibited successful transfer are Jamaica and Singapore. We have identified certain factors which we believe facilitated successful transfer : provision of extension officers, greater emphasis in project activities on extension work, financial support such as capital start-up funds for prospective farmers and the lack of other viable economic opportunities. Given the absence of some of these factors in some projects, it is to be expected that a low adoption rate of the developed culture process was encountered.

3.2.3 Research Capability

Section 3.2.2 established that all project personnel who had training, completed their training activities. We concluded there is room for further maturation in the scientific analytical skills of the project personnel. This section evaluates whether the projects have built up the scientific and management capabilities of the staff of the recipient institutions. Thus there is a link between the training that is provided to build up the technical expertise with this issue of whether the projects presence in the recipient institutions have enhanced the scientific and management capabilities of the recipient staff and institutions.

Our evaluation of this area is based on the response to questions which we posed to the project personnel during project visits, and other indicators such as the number of project personnel who were trained or shown some of the techniques by the returning IDRC trainees or project leaders, and the number of scientific papers published or presented at conferences.

All project personnel who went for training stated that they have utilized the techniques and information learnt during their training in project activities. However from the consultants' reports we know that further improvements in technical expertise of the trainees can be made. With the lack of prior experience or knowledge of mollusc culture research all the project staff also indicated to us that most of the techniques and knowledge required in their research activities were developed through project activities and training (the exception is Singapore). Therefore the opportunity to conduct mollusc culture research plus the training provided, enhanced the research capabilities of the project staff. Even in the case of Singapore, the project leader had an opportunity to participate in the fabrication of machines required for the harvesting process. When we posed the question to the project leaders of whether the project activities had increased their research skills, all project leaders stated that their research skills had increased due to the project activities.

Another indicator of building and enhancing research capability is the number of project personnel who were trained by staff who were on training courses. Table 6 shows the number of project staff members who have received in-country training by project staff who have completed IDRC sponsored training courses.

TABLE 6
NUMBER OF IN-COUNTRY TRAINING OF PROJECT STAFF

Project	Number of In-country Training of Project Staff
Oysterculture (Sierra Leone) Phase 1	40
Phase 2	Nil
Musselculture (Singapore)	4*
Oysterculture (Jamaica)	4
Mariculture (Peru)	5
Oysterculture (Sabah)	6
Oysterculture (Sudan)	5
TOTAL	64

* The project leader also reviewed the techniques with ASEAN countries personnel - a total of 15 were shown the techniques.

Source : Interviews and Project Progress and Annual Reports.

A total of 64 staff of the projects received varied types of training from demonstration of techniques learnt, to formal lectures and slide presentations. If we combine this number with the total number of staff (29) who were sent for IDRC sponsored training, such as study tours, short term and degree courses, we find that 93 of the projects' staff have benefited from the presence of these mollusc research projects in the six countries.

The number of scientific papers published and presented at conferences is also an indicator of the enhancement of the research capability of the projects' personnel*. Table 7 provides the number of papers published or presented at conferences by the projects' staff. (see Annex 3 for details of papers).

* Included in this are papers published as occasional papers of the recipient institutions.

TABLE 7
PAPERS PUBLISHED OR PRESENTED AT CONFERENCES
BY MOLLUSC CULTURE PROJECT STAFF

Project	Number of Papers Published/Presented
Oysterculture (Sierra Leone)	9
Musselculture (Singapore)	3
Oysterculture (Jamaica)	3
Mariculture (Peru)	Nil
Oysterculture (Sabah)	2
Oysterculture (Sudan)	1
TOTAL	18

The Sierra Leonean project which has the highest number of publications, though interestingly it is not as successful in attaining project objectives compared to those projects which had fewer publications.

Consultants: Consultants were contracted to provide technical assistance to the six projects. The technical advice ranged from biological analysis to marketing and processing techniques and analysis. In the case of the Peruvian project, the research program of activities was worked out by the consultant for the researchers to follow. Five different consultants were used in the course of the six projects (three consultants were for the biological aspects of the research and two were for the socio-economics and marketing areas of the project activities). However, the advice given by the consultants to the projects were on different areas of the project activities, with the exception of the Sudan where two different consultants providing technical advice in the biological aspects of the research were used. Table 8 gives a breakdown on the frequency of the use of consultants for the six projects.

TABLE 8
CONSULTANT VISITS FOR MOLLUSC CULTURE PROJECTS

Project	Number of Consultant Visits	Number of Different Consultants Used
Oysterculture (Jamaica)		
Phase 1	3	2
Phase 2	1	1
Musselculture (Singapore)	2	2
Oysterculture (Sudan)	6	3
Oysterculture (Sierra Leone)		
Phase I	5	2
Phase II	2	2
Mariculture (Peru)	2*	2
Oysterculture (Sabah)	6	2
TOTAL	27	

Source : PROMIS and Project Files

* A Canadian oysterculture biologist was scheduled to make 3 visits to advise on oyster/clam research and culture, and a Spanish biologist was to make 2 visits to advise on musselculture research and techniques. All five visits were not utilized. The two visits indicated in the above table were a project visit to plan activities and a recent visit (Sept. 1984) to evaluate the technical progress.

All the project leaders interviewed, with the exception of one (Singapore), stated that the provision of consultants has increased their research capabilities. According to the project leaders, the technical advice given by the consultants was useful in their research activities. All project leaders, including senior administrative personnel of the Ministries interviewed, suggested that the consultants' visits should be stretched over a longer period to enable their staff members to benefit fully from the consultants' expertise. In addition, the project leaders further commented on the shortness of IDRC program staff visits and indicated that they should be longer as in certain instances the IDRC staff member provided technical advice. During our project site visits, (Jamaica, Malaysia) IDRC program staff's

technical input was evident in the research techniques carried out by the project personnel. Furthermore, these visits by IDRC program staff provided the project personnel with links to the parties in the world conducting mollusc culture research and the visits also had the effect of encouraging the project recipients in their project activities.

3.2.4 Linkages

According to our interviews, linkages between project recipients and other staff and institutions in the country or region occurred in 3 projects: Sierra Leone, Sudan and Jamaica. In the Sierra Leone project, consultation occurred between the project personnel who were located in the government ministry and the faculty of the University of Sierra Leone. Formal consultation was structured also between the Ministry of Natural Resources in which the project was located, and the Department of Water and Sanitation over the quality of water.

The more substantial linkages identified to us were those that occurred in Jamaica and Sudan. The Sudan project had formal contacts with the Regional Governor, local universities, private sector companies which were exporting shells, schools and the Sudanian Navy through lectures, demonstration and meetings. For the Jamaica project, research collaboration occurred between the project recipients who were in the Ministry of Agriculture and the faculties of the University of West Indies and the University of South Florida. A pre-feasibility study was conducted dealing with the microbiological quality of oysters and associated seawater at the different culture sites. The strength of such linkages is difficult to measure and from the descriptions provided by the project personnel they are at the level of liaisons, with the exception of Sudan where consultations and divisions with the Regional Governor and Local Assembly has led to some funds being allocated to the project.

Besides these linkages, we find no exchange of information occurring between the projects. Four project recipients (Malaysia, Peru, Sierra Leone and Singapore) received information concerning the

activities of the other projects through the IDRC program staff. IDRC staff therefore was the go-between in terms of exchange of research experiences through monitoring visits. This means that all six projects worked in isolation of each other with the IDRC program staff providing the exchanges. Despite this situation, all project leaders interviewed expressed the wish to know what the other projects are doing in their research.

Summary

1. a) The presence of the projects in the six countries did increase the scientific capabilities of the project personnel to the extent that they were able to undertake mollusc culture research. A total of 93 project personnel benefited from the presence of these mollusc research projects in the six countries in terms of opportunities to undertake mollusc culture research and development.
 - b) The use of consultants increased the research capabilities of the project staff and longer consultancies were requested by the project staff. Furthermore, more monitoring visits by IDRC program staff were encouraged by the project recipients as these visits would provide not only technical advice but the necessary support for their project activities.
2. In terms of the development of institutional linkages between project recipients and other institutions, three projects had developed these linkages. Most of these linkages were at the liaison level, however, in the case of Sudan project, the liaison activities have led to the contribution of financial support from the regional government where the project research sites are located.

3.2.5 Production

Of the six projects evaluated, in our view 4* projects had developed a culture production system which could sustain the continuous culturing of oysters. These projects are located in Singapore, Malaysia, Sierra Leone and Jamaica. It must be emphasized that the viability of these systems was considered only in relation to the biological culture process without considering either the economic viability of the culture system or the successful transfer of the developed culture system to prospective farmers. In other words, a biologically viable culture-production system has been developed to an extent in four projects to a stage whereby it is possible for transfer. However, it is our opinion that, for successful adoption of the developed culture system, several factors have to be considered: the economic viability of the process developed to culture molluscs, the support provided by the local government for extension activities, the demonstration and extension activities to transfer the process, the local/international market potential of the molluscs produced, and the local employment or economic opportunities.

Local government input into the development of a viable culture production system and extension activities :

Continuous government support to the development of a viable production system and extension activities is a factor for the successful transfer of the developed culture process. Of the four projects, the Jamaican and Singapore projects enjoyed continuous government support. In the former case, the support from the government even increased in financial and human resource commitments during the later phases of the project. **The continuous support of the Government of Jamaica in the areas of operating costs, provision of extension officers and start-up capital funds for prospective farmers has facilitated the successful adoption of the culture process.**

* From a recent consultant technical evaluation, the Sudan project has reached a stage whereby pilot testing is envisaged, however, substantial research is still targeted for a proposed phase II.

When support from the government wavered towards the end of the projects, as for example in Sabah and Sierra Leone, there was no successful adoption of the culture process.* In the case of Sabah, two years following the completion of project, we note of the Sabah government continuing in culture trials at three different areas in Sabah without IDRC support. Therefore, we are led to believe that the drop in government support to oysterculture research towards the end of the project was a result of personality conflicts.

Though it was not stated, there was very little indication of government support for the project in Peru. The Sudanese project leader voiced the inadequate support provided by the government but the project has received funds from the regional government where the project is located. Prospects for future support from this source and, as well, from the Agricultural Research Corporation seems to be bright.

Such an assessment of support for mollusc culture research and the development and transfer of the culture process should be reflected upon vis-à-vis the priorities placed on mollusc culture research by the governments in the countries where the projects were located. Our discussion in section 3.2.1 has alluded to this by examining whether mollusc culture research was occurring in the countries prior to the start of IDRC projects. There is very little 'hard' data available for us to correlate vis-à-vis the resources the government has channelled into mollusc culture research. According to our interviews, the recipients' contributions to the IDRC projects are the sum total of the available resources in the six countries directed towards supporting mollusc culture research. Mollusc culture research, as we know, is not as widespread as other forms of aquaculture research. For example, the

* In the Sabah project, there was the formation of a commercial farm based on the developed culture process. According to records it went bankrupt due to the high mortality rates of the oysters. Unfortunate as this is, there was, however, no successful adoption of the culture process even though 40 farmers were shown the developed culture oysters. We are led to conclude that there are other inhibiting factors that prevented successful adoption.

consultative mission on "Research Reinforcement in Aquaculture for Countries of South and South East Asia" has indicated the low priority given to this type of research by the regional institution in S.E. Asia which has capabilities to undertake mollusc culture research; albeit, the report has indicated that research on bivalves should be a priority. We do not doubt the legitimacy of the identification of this priority by the consultative mission; however, what we do want to underscore is the low priority placed on mollusc culture research in South and S.E. Asia, as evident from the information provided by the consultative mission. In light of this, and by reviewing the priority placed on mollusc culture research by the countries in which the six projects were located, we can identify the following countries in which mollusc culture research has been noted as an area of focus : Malaysia and Singapore.*

Market Opportunities and Costs:**

According to Tai and Ishak (1984:1), one of the major constraints limiting the growth in the production of the bivalves is the market potential for these molluscs. In 1982, the world production of bivalves was 3.4 million metric tons, which only represented a 4.4% of total world production of all living aquatic resources (Tai and Ishak, 1984:2). It suggests that the market potential for molluscs on a world wide level is not one of unlimited demand. Tai and Ishak's (1984:35-37) study has further suggested that the consumption of molluscs on a world scale tend to be concentrated in a few countries:

* The Ministry of Fisheries of Peru has established regulations for shellfish farming in terms of granting concessions and the order of priority of granting these concessions is:

- 1) Research and experimentation, and small scale farming;
- 2) Experimentation and farming by companies;
- 3) Industrial scale cultivation.

** Specific studies were funded to obtain statistics on the production and consumption patterns of molluscs in the countries where the projects were located and also worldwide production and consumption patterns.

Oysters : (U.S.A., Japan, France, Korea,
Mexico, Canada, New Zealand);

Mussels : (Spain, France, Thailand, Belgium,
Chile, Netherlands, Denmark, Peru)

Scallops : (U.S.A., Japan, Canada, France,
Australia)

With the exception of Thailand, consumption of oysters, mussels and scallops tends to be concentrated in the temperate countries.* This pattern of consumption, with its concentration in the temperate countries, should be considered in reviewing the market potential locally of the molluscs produced by the IDRC projects (the exception would be Peruvian and Sudanese projects). It should also be noted that 67% and 73% of the world production of oysters and mussels are by culture techniques, whereas only 20% of world production of scallops is by these techniques. This means that as the natural beds are depleted due to overexploitation, the expansion of mollusc production in the future can only be from cultured sources (Tai & Omar, 1984:28). In this respect, research for efficient culturing of oysters and mussels would be important. In the case of the IDRC projects (Sierra Leone, Jamaica, Malaysia and Singapore) that are culturing oysters of a different species than those analysed by Tai and Omar (1984), the acceptability of the product by foreign consumers would have to be reviewed.

Tai and Omar (1984:31-32) also suggest that generally consumers prefer fresh or frozen oysters, mussels, and scallops. The study therefore alerts us to consumer preferences and it should be considered seriously in future post-harvest activities being sponsored by the Centre.

* It should also be realized that Tai and Ishak's study covered different species of oysters, mussels, and scallops than those produced by the IDRC projects. Due to the lack of available information on the species under culture by IDRC projects, it was decided that at the very least available statistics on oysters, mussels, and scallops would be helpful for our analysis.

Oysters

According to Tai and Omar (1984), 85% of the world oyster production is concentrated in the U.S.A., Japan, Korea and France. Oysters account for 27% of the world production of bivalves. For the countries in which IDRC projects are located, where the oysters were being cultured for consumption, such as Malaysia, Jamaica, and Sierra Leone **there are no indications of a high local demand for oysters.** The study of Elliott's (1984) on oyster consumption in Sierra Leone has provided data which is not very promising in terms of future market demands for oysters in Sierra Leone. A projected demand level of 50 metric tons is projected for 1990. With oysters occupying only 6% of the food expenditures of a Sierra Leonean family, it further demonstrates the 'occasional' nature of this food item in the daily diet of the Sierra Leonean. Given the historical trend of oyster consumption, which occurs mainly in the developed countries, and noting the low volumes of demand locally for oysters in countries such as Malaysia, Jamaica and Sierra Leone **any increased production of oysters in these countries would have to be exported.** If this is the case, then the form of oysters produced would have to be examined carefully since the fresh and frozen forms of oysters are the ones most widely consumed. Therefore post-harvest harvest activities geared towards these forms would have to be considered.

Tai and Omar (1984) have also estimated that oyster consumption will decrease in the U.S., which is currently the world's largest consumer of oysters. **The reason for this is a projected decrease in production and an increase in prices.** Such conditions therefore will be conducive for the oysters being produced in the tropics, provided production can be increased and the product acceptable to the American consumer. Therefore, without having to develop markets in the countries which IDRC has projects, (which is costly and cultural moreways might inhibit consumption), the other avenue would be to export oysters in light of the market potential of this product. **This consideration however should be evaluated vis-à-vis other factors such as costs of production, post-harvest processing and handling techniques, and production opportunities.**

Mussels

Mussels as compared to oysters and scallops according to Tai and Omar (1984:49) are consumed mostly by the poor and considered the common man's food. Therefore, the selling price for mussels is low. If this is the case, exports of mussels from the countries in which the projects are located would be hindered unless the cost of production can be kept low. The project in Peru which was targeted to undertake studies on mussels would have the potential of the mussels produced being consumed locally as Peru does have an internal market for mussels averaging 12,500 metric tons for the past nine years. For the Singapore project, where the local market demand for the product is low, the only avenue would be for export. This has been the avenue chosen by the recipient.

Tai and Omar (1984) have also estimated that world production of mussels will decrease. However, in South East Asia mussel production in Thailand is expected to increase. With the expected drop in world production, there is therefore the potential for the export of the mussels from the countries in which the IDRC projects are located.

Scallops

The three major producers of scallops in the world from 1972-1982 are the United States, Japan and Canada. The three major producers of scallops are also the world's three major consumers, consuming an average of 104,000 tons per country for the year 1982. Peru for this period has also produced scallops averaging 2600 tons per year. Of the world's total production of scallops, only 20% of this production level is produced by culture. Therefore, the potential for scallop production to increase is high if culture techniques for producing scallops are increasingly adopted. According to Tai and Omar (1984:77), the future market demand for scallops will continue to be high.

Another study of the market demand for scallops in Peru funded for this evaluation has noted also of the increasing consumption rate of scallops in Peru (Rodas, 1984). The rate of consumption increase averages about 25% annually. Scallops consumption in Peru fluctuates around 2945 metric tons in 1973 to 5599 metric tons in 1979. Most of the scallops harvested in Peru are consumed in the metropolitan cities. For example, the city of Lima accounts for 52% of the total annual Peruvian consumption of scallops. A significant feature of the consumption pattern of scallops in Peru is the preponderance of institutional over family consumption. According to Rodas (1984) this institutional consumption is partaken mostly by the higher and middle income segments of the Peruvian population who are in a position to pay high prices for scallops. Given this feature of the market, there is a demand for scallops in Peru with the major consumers from the upper segments of Peruvian society.

Mother-of-Pearl Oyster

World production of mother-of-pearl shells has dropped from 754 tons in 1977 to 323 in 1982. The main producing countries of these shells are Japan, Australia and Fiji. Demand is noted to be erratic and this is accounted for by the lack of a sustaining source of supply. According to Ali (1985:39-42), the countries that are major importers of these shells are Italy, Saudi Arabia, West Germany and East Germany. For these countries, the average annual volume of imports between years (1966-1982), were 21 million, 12 million, 9 million and 8 million metric tons respectively. The shells are used for the production of consumer items such as buttons and jewellery, etc. There are also signs that these shells are also being used as poultry feed. Expected local consumption in Sudan is about 100-150 tons annually. Clearly, there is a market potential for these shells as poultry feed.

Ali (1985) has also indicated a series of conditions that might reduce the volume of shells exported for use in the manufacture of consumer items. The brittle nature of the shells following storage of 2-3 years reduces their quality. In addition, the various governmental

regulations such as increased export duties, minimum export prices, and the delays in obtaining export permits are potential barriers to a successful export strategy. In view of these potential barriers, the use of these shells as poultry feed should be considered. In this case, the lowering of costs of culturing the oysters will have to be reviewed if this avenue of the utilization of the shells is pursued.

Cost of Production*

Studies were funded for this evaluation to calculate the economic costs of producing the molluscs and the economic viability of producing these molluscs. We will consider the economic viability of producing the molluscs in each project which was identified for evaluation. For the Sabah project, according to the consultants, (Kuperan and Omar, 1984) the cost of producing the oysters is economically viable (See Annex 4). The most suitable farm size for a local fisherman to make a living is a one acre farm providing a minimum monthly income of \$400 (MYR) that will be attractive to artisinal fishermen. As a part time venture, a 0.5-acre plot of farm is needed. The evaluation was based on financial analysis utilizing appropriate sensitivity tests.

Sensitivity analysis performed showed that for a 20% fall in the price of oyster, a farm of 0.5 acre size will still have an internal rate of return of greater than 38%. A farm of 0.25 acre in size will not be viable only after the price of oysters drop by 50%. The sensitivity tests also considered the mortality rate of oysters produced in a 0.5 acre size farm. In order for the farm to be not economically viable will entail a mortality rate of 50%. The economic analyses therefore suggests that oysterculture farming in Sabah would be an economically viable activity if it is undertaken according to the size of the farms mentioned above.

* The financial analyses of the Malaysian and Singaporean projects are based on experimental production systems. Furthermore, in the Malaysian case, calculations of cash flow for different sizes of oyster farm were based on multiplying fixed and variable costs by the unit farm size increases. In a way, certain variable costs could be lowered for the large unit farms which mean that the return to investments would be slightly higher than that projected by the consultants.

The economic analysis study of scallop production undertaken by a Peruvian consultant is not very useful for our consideration of the costs of the culturing of scallops in Peru.* Some heroic assumptions were made which in our view undermine the results. Because of this it is not possible to consider whether it is economically viable to culture scallops utilizing the proposed culture techniques to be developed by the project. It is recommended that economic analysis be undertaken when data is available following **further progress in the development of a suitable culture system for scallops.**

The economic analysis of the Jamaican project was undertaken by the current project leader. According to this analysis, a minimum of 10 oyster rafts will be required if a fisherman is to rely on culturing oysters as his livelihood. A minimum of 4 oyster rafts will be needed if a fisherman is to consider this activity as an extra source of income in order for him to recover his capital and labour input. The financial analysis indicates that for a farmer with 10 oyster rafts, his annual income from the harvest of oysters will be JMD 5,432.52. An artisanal fisherman in Jamaica earns approximately JMD 2,000 - 3,000. This would indicate that it is profitable for the fisherman to undertake oysterculture. The above calculations are based on a 50% annual depreciation of fixed capital which is high. Furthermore, labor costs were included in the above calculation which in the case of any artisanal fisherman, most of this labour input will be lower. Presently, we are still awaiting to receive further information (such as cash flow) from the project leader in order to assess accurately the economic viability of the oysterculture operation. Because the analysis was based on a minimum number of oysters produced per raft, the available information suggests that the oysterculture system developed is economically viable.

* The consultant utilized data on the culturing of scallops which are derived from current practices of culturing scallops in Peru (bottom culture). He was supposed to utilize the information on the costs of culturing scallops from the project leader. Evidently this information is not available from the project leader for financial analysis to be undertaken.

For the project in Singapore a financial analysis was undertaken and published in an IDRC publication. According to the benefit cost analysis varying internal rates of return from 14.4% to 40% were estimated over a 5 year period for different raft sizes. Labor input of an average of 5 persons/year were required to provide the rates of return estimated. **This suggests that the size of operation would be of a scale much larger than a family size farm.** Sensitivity tests indicated that increases in labor cost would have a greater impact on production than any decrease in fixed capital. It is economically feasible to undertake musselculture in Singapore provided farm sizes of at least 0.5 - 0.75 hectare are considered. Given that labor to operate these sizes of farms is on the average of 5 persons per year, consideration should be directed towards whether an individual can mount the size of such an operation. Our project visits indicate that capital start-up funds for musselculture in Singapore are difficult to secure, even from the Singapore Development Bank.

Economic analysis of culture production costs were also undertaken by the recipients of the Sierra Leone and Sudan projects. For the Sierra Leone project, two types of culture techniques were calculated in terms of production costs (Elliott, 1984). Yield differences favour the raft method however costwise the rack method shared a break even cost advantage of 35%. With yield difference (27%) being favourable to the raft method and break-even cost favourable to the rack method, the consultant concluded that either method would be suitable for Sierra Leone. However, the raft method is a more expensive process to culture oysters especially with the fixed costs involved.*

The analysis undertaken by the Sudanese recipient requires further clarification. According to the recipient the culturing of the mother-of-pearl shells is an economically viable operation with an internal rate of return of 50%

* No sensitivity tests were performed by the consultant to the effects of oyster price decreases.

Local Employment and Economic Opportunities

The success of the adoption of the developed culture system by the local fishermen in the countries where the projects are located in our view is also **contingent** on the employment and economic opportunities available in these countries. During our visits to the project sites, project leaders in their interviews discussed the employment prospects in their countries and the possibilities of fishermen and the unemployed taking up culture activities. Of the six projects, four of the countries (Jamaica, Peru, Sudan, and Sierra Leone) were experiencing employment conditions which in our view were conducive for successful adoption of the developed technique. Jamaica had a high unemployment rate in the rural areas and in this respect oysterculture as an economic activity would be viable. Peru, Sudan and Sierra Leone also shared this condition with the added asset of local fishermen already undertaking the harvesting of oysters and scallops. For Singapore, Sabah, and Malaysia, the opposite condition prevails. In Singapore's case, with the available economic opportunities in Singapore, oysterculture is not viewed as an attractive economic vocation unless the individual is pursuing a large commercial scale operation as we have seen in our project visit. Presently, Sabah is experiencing the availability of other economic opportunities in the field of oil palm, cocoa and lumber. Therefore, it was difficult even for the project leader to recruit workers for the project. The workers employed in the project were refugees from Indonesia and the Philippines. In light of this, the adoption of oysterculture in Sabah will be hindered.

In reviewing the development of the culture system for transfer to the fisherman, we also examined the advantages and disadvantages of locating projects in governmental ministries instead of in universities. We questioned the project leaders to obtain their opinions of this in light of their experiences.

To the project leaders, the advantages of locating mollusc culture research in government ministries are:

- i) government research is related to development;
- ii) the government can provide logistical support and thus will have the advantage of transferring the developed culture system;
- iii) the government agency is aware of the needs of its citizens.

Functionally, government ministries do have the mandate to undertake projects for socio-economic development. Therefore, the transfer of the developed technology would be facilitated by the participation of a government ministry in this area. The disadvantage of locating mollusc culture research in government ministries, according to the project leaders, is the lack of scientific research expertise in some of the departments of fisheries of government ministries. This condition might not be applicable to universities; however, most of the research undertaken in universities is more related to academic concerns. **In our view, the optimum modality would be to locate projects in government ministries with university departments providing research support.** This conclusion is offered only tentatively as considerably more analysis would have been necessary to put forward such a review with confidence.

Summary

1. Of the six projects evaluated, 4 projects had developed a culture production system which could sustain continuous culturing of oysters. The viability of these systems were considered only with respect to the biological culture process. In terms of successful transfer of the culture production process, only two projects showed indications of adoption by local farmers : Jamaica and Singapore. The Jamaican project had continuous local government support that facilitated the successful transfer through the provision of extension services and capital start-up funds. No doubt, market potential and local employment conditions also affected the successful transfer.

2. i) The market potential studies suggest that the market for molluscs is not one of unlimited demand. Molluscs consumption are concentrated mostly in the temperate northern countries with the exception of the consumption of mussels in Thailand.
- ii) The local market potential for oysters in Malaysia, Jamaica and Sierra Leone are limited. Market potential studies also suggest in the case of Sierra Leone, the amounts are consumed by the urban and upper strata of Sierra Leonean society. There is however a potential for the oysters produced to be exported to the markets overseas. In this regard, cost of production, post harvest processing and handling would have to be examined carefully.
- iii) The local market demand for mussels is low and the only avenue for the products produced by the developed techniques of the Singapore project would be for export. This is currently being done. Because mussels are considered the poor man's food, further export increases would be contingent on lowering the cost of production.
- iv) There is a local demand for scallops in Peru and the consumption increase is estimated at 25% annually. Like the case in Sierra Leone, scallops are consumed in Peru by the upper and middle income segments of Peruvian society.
- v) With the available information to date there is a market for the mother-of-pearl oysters in Sudan and overseas. The possibility of these animals being used for animal feed further increases the market potential of the product.

3. i) Financial analysis indicate that it would be profitable to culture oysters in Sabah where a one-acre farm would provide sufficient income that will be attractive to artisinal fishermen. As a part-time venture, a 0.5 acre farm is proposed. These calculations are based on experimental production systems. Other factors such as local employment opportunities and the availability of capital start-up funds would also have to be considered. The current availability of other employment opportunities and the lack of capital start-up funds in Sabah would hinder the adoption of the developed culture process.
- ii) For the Jamaican project, a minimum of 4 rafts will be needed if a fisherman is to consider undertaking oyster cultivation as an extra source of income. Approximately 10 oyster rafts will be required if a fisherman is to undertake it as his primary source of income. In our view, considerable government support and input will be needed continuously in order for this activity to be undertaken successfully. Currently production support is provided to fishermen who have adopted the culture production process.
- iii) The financial analysis undertaken for the Singapore project indicates that substantial capital start-up funds are needed to undertake the developed culture process. It requires a labour input of approximately five persons which would shift the production operations to a scale much larger than a family size farm.
- iv) The financial analysis of the Sierra Leonean project is inconclusive. Raft and rack cultures are considered suitable for production operations. It would be financially difficult for a prospective fisherman to undertake the costly raft culture process developed by

the project in view of the current economic conditions in Sierra Leone.

4. In our view, the optimum modality would be to locate projects in government ministries with university departments providing research support.

3.2.6 Alternative and Future Prospects

The recipients were asked to identify future areas of mollusc culture research in light of their experiences which the Centre could support. A number of research areas were identified by the recipients:

- 1) The development of hatcheries;
- 2) Studies of other species of molluscs;
- 3) Depuration studies;
- 4) Marketing and Processing of oysters, mussels and scallops;
- 5) Studies on the transfer of spat over long distances;
- 6) Further improvement on the design of spat collectors.

Research on the development of hatcheries is an area which should be reviewed carefully. Because the culture process of the six projects are dependent on natural spat collection for grow-out, the system of culture is dependent on this natural collection process. **The risk of pollution of the spat collecting areas are most pronounced for the Jamaica, Sudan and Sabah projects.** Provided that controls are established to prevent pollution, sources or sites for the production of spat will have to be located or established. In the Jamaican case, it seems that the Bowden area where the spat is being collected is the only area which can provide spat for grow-out in sufficient quantities. Therefore, serious efforts should be made to discover alternative sites for spat collection or the establishment of hatchery facilities should be examined. The development of hatchery facilities would undoubtedly increase production costs and as well, technical obstacles would also have to be faced. If this route is chosen, the advantage would be a more secure supply of spat for the fishermen, but it would shift the

proposed oysterculture activities to produce a higher priced product. For the Jamaica and Sudan projects, this might not be a serious factor but the Sabah project which directed its activities to the rural poor, this shift towards hatchery facilities for spat collection would change the thrust of the project's direction. Furthermore the development of hatchery facilities would institutionalize the role of the government in oysterculture activities.

Areas (2), (3), (4) and (6) are activities which were included in phase I of project activities. Areas (2) and (6) focus on more research work being undertaken to improve production. The study of other species of molluscs (Area 2) should be considered only after some basic market potential studies indicate there are markets for the proposed species to be studied. For post harvest activities (areas 3 and 4) this interest to undertake studies in these areas should be encouraged, especially since the market potential studies have suggested that they are important aspects for the successful marketing of the molluscs produced.

We also reviewed future areas of training support with the recipients. The areas identified are:

- 1) Post harvest training : processing techniques;
- 2) Statistics;
- 3) Hatchery management;
- 4) Pollution control;
- 5) Socio-economic analysis;
- 6) Extension;
- 7) Depuration.

Clearly, the identification of these areas should be included in future areas for training. Area (7) has been a part of project activities (Singapore). Without spending vast amounts of funds for training in the above areas and the accompanying the loss of key personnel to undertake designated project activities, it might be useful to consider including in future projects, research teams which have personnel with expertise in the above areas wherever possible.

The issue of **networking** was also discussed with project leaders to ascertain whether there is a wish to network with other projects. All project leaders were unanimous in expressing the wish to join network activities. **Reasons cited are: an opportunity to help each other in their research activities and an opportunity to exchange information. Networking would strengthen the research skills and subject the research conducted to a peer review analysis which might improve the quality of the research undertaken. The issue of isolation would be alleviated. The commonality of research objectives among the six projects provides the potential for networking to occur. Costwise, it would be expensive to mount a global network. A regional network would be more feasible. As IDRC has had extensive experiences with networking, this modality should be considered, especially with the information and knowledge that would be required still for future activities in this area.**

4.0 CONCLUSION

4.1 Achievements

The evaluation indicated that a substantial number (29) of people were trained in mollusc culture research through short term training, study tours and degree courses. Besides these IDRC sponsored training courses, 64 other project personnel were given in-house demonstration of mollusc culture research and techniques by the returning IDRC trainees. Therefore in terms of benefits to the countries in which the IDRC sponsored projects were located, 93 nationals of these countries have benefited from IDRC project funding.

4.2 Since the projects' research teams (with the exception of Singapore) did not possess much prior research experience in undertaking mollusc culture research with the training provided and the opportunity to undertake mollusc culture research, they have developed their research capabilities to the extent that they have acquired enough knowledge and experience to conduct further mollusc culture research. (Notwithstanding this, the provision of consultants for technical advice in further stages will still be required).

4.3 The biological research undertaken in the projects has produced publications and scientifically, it has been demonstrated that mollusc culture systems can be established successfully in the Tropics.

4.4. In terms of transfer of the developed technology to prospective farmers, 22 people have adopted the developed culture process and thus have benefited from the research supported by IDRC. Successful transfer only occurred in the Jamaican and Singaporean projects. In our view further support for extension and research activities in the case of the Jamaican project would increase the number of people adopting the developed culture process. Due to current economic conditions in Jamaica we are optimistic that there will be further successes in the transfer of the developed technology, provided support from the Government of Jamaica continues at the level of Phase II project activities. For the Singaporean project, the cost of undertaking the

developed culture process might hinder further rates of adoption of the developed process unless capital start-up funds can be provided. We have no reason to believe that these funds will be available, and thus we are cautious in terms of our projection for a growth in the adoption rate of the developed culture process. Notwithstanding this, there have been export shipments of over 20 tons of frozen mussels to Japan produced by the developed culture process.

ISSUES

The evaluation pinpointed some common issues which pervaded the six projects. Notwithstanding the historical particularities which some of the projects possessed in their early developmental stages, there are however, common issues which affect the progress and the attainment of project objectives.

4.5 Research : Human Resource and Institutional Capacities

With the exception of the Singapore project, the other recipients did not possess the necessary research experiences to undertake mollusc culture research. The Jamaica and Sierra Leone projects did have the basic research capabilities to conduct the research but they were not at the stage which the Singapore recipient had reached. This meant that the training of project personnel was crucial towards the projects' progress. Besides this, not all six countries were at the same stage of development in terms of institutional and research capacities. Those projects such as Singapore, Sierra Leone (Phase I) and Jamaica which had stronger institutional and research capabilities experienced fewer problems in undertaking the research aspect of the project activities. For projects with the main emphases on conducting mollusc culture research (to produce useful results for the development of a production system) rather than capability building, the successful attainment of this objective was hindered by the research capabilities of the project staff (with the exception of Singapore). **Even with the provision of training, the research capabilities of the projects' staff were not developed to the stage as one would expect.** The provision of consultants to the projects alleviated some of these problems but consultants' recommendations were ignored in certain cases (for example,

trials of rack and raft culture were advised, but some recipients chose to concentrate on one culture technique; more experiments were suggested but recipients did not follow through with technical advice). In view of the strength of the research capabilities, it would be ambitious for IDRC to expect the recipients, such as Sudan, Peru and Sabah, to successfully complete all the research objectives. **We are led to ask whether it would have been more feasible for IDRC to focus more on building the research capabilities of these recipients, instead of encouraging these recipients to conduct mollusc culture research and to produce useful research results.**

The provision of consultants did aid the progress of the projects but this was of short duration. The capability to do the research in most cases was developed to an extent to undertake useful research only towards the end of the projects. We do not discount the idea of "learning-by-doing" **but the extent to which one can expect recipients to conduct mollusc culture research and to produce useful results without much prior research experiences in this area must be re-examined.**

Included in the projects' objectives were also dissemination and extension activities. These activities included the training of local farmers to undertake mollusc culture utilizing the culture system developed. The projects' personnel were supposed to undertake these designated activities even though most of the staff (with the exception of Jamaica) were research-type fisheries officers with no background in extension training. Extension activities were new work environments with which they had no experience. There was no inclusion of extension officers or the participation of extension agencies in undertaking these activities (with the exception of Jamaica) even though the countries in which the projects were located had such agencies. This issue is not particular for the six projects evaluated but is also present in other AFNS projects, [Cassava (Indonesia), Sorghum Improvement (Ethiopia), Aquaculture (India), By-Products (Mexico), Forestry Technology (Andean Pact) and Grain Milling and Utilization (Nigeria)] which have been evaluated according to a summary note prepared by D. Daniels where this weak linkage between the research institutions and extension agencies was also noted.

Therefore it is not unexpected that adoption of the culture process was low. Where extension officers were assigned to the projects such as in the case of Jamaica, the adoption of the culture process by farmers was more successful. We are not suggesting that with the provision of extension agents it would mean that the adoption of the culture process would be assured. There are abundant studies to indicate the unsuccessful transfer of technology even when extension services were provided.* However, by not including extension agents or agencies with experiences in disseminating and demonstrating a developed technology, it would undoubtedly assure a low rate of adoption of the developed culture process.

Successes in the adoption of mollusc culture is contingent not only on good extension work, other factors do come into play as we have discussed in chapter 3 : the economic viability of the developed culture process, the support provided by the local government such as capital start-up funds etc., the market demands for the product and the local economic-employment opportunities.

4.5.1 Government Support

The successful attainment of project objectives is contingent on continuous government support. The Sabah and Sierra Leone Phase II are good examples of the lack of continuous government support. Although there are different reasons for the drop in government support towards the end of each project, whenever government support wavered we find the projects progressing slowly. We believe that continuous local government support is a key factor in ensuring the progress of the projects and as well the morale of the project's staff. The priority placed on mollusc culture research and development by the local governments would be an indicator to consider of possible government support.

* See, for example, W. Whyte, Participatory Approaches to Agricultural Research and Development, Cornell University Rural Development Committee, 1981 : 4-7.

4.5.2 Staff Departures

Staff departures affected project activities and the attainment of project objectives. Temporary or permanent staff departures occurred in five projects (Singapore, Jamaica, Sabah, Sudan and Sierra Leone). The permanent/temporary departures of staff affect more acutely those projects which had a weaker research capability than those which did not. The projects in Sabah, Sudan and to a certain extent Sierra Leone and Jamaica were affected by permanent/temporary staff departures from the project. For the Singapore project, which had prior experience in mussel culture research, the departure of the project leader during the project did not impact acutely on the project. **Perhaps to ensure that staff departures do not affect projects' progress, ability and responsibility to do the research and the corporate memory of the project should be distributed among the key personnel.**

4.6 Mollusc Culture Production Systems : Development and Transfer

With the exception of Sudan, the projects were funded on the basis that the developed culture systems would provide food for the rural poor. The main rationale on IDRC's part to support mollusc culture research was based on the biological fact that molluscs are efficient protein sources of food and the Third World has the natural advantage of an environment conducive to mollusc growth. It was further argued in the project summaries that molluscs are not luxury food items in the Third World but rather the food of the poor.

In the development of the culture systems for transfer to prospective farmers, there were no attempts (with the exception of Sierra Leone Phase I) to calculate the economics of production. As the systems were developed, it was found that the cost of producing the molluscs were high for rural poor consumption. Consequently the target consumer group had to be shifted. Besides the cost factor, there was no high local market demand for the molluscs produced (with the exception of Sudan and Peru) in the countries where the projects are located. This is confirmed by the market potential studies undertaken

for this evaluation. Furthermore, in the case of Peru, the scallops are consumed by the upper and middle strata of Peruvian society which places in doubt the rationale of the Centre's funding. No market demand analyses were done prior to the implementation of the projects.

In our view, the Centre's funding rationale for mollusc culture research should be reconsidered, especially when the mollusc consumption is low among the rural poor who were the targeted beneficiaries of IDRC funds. **However, if the emphasis is shifted towards more economic opportunities for the rural fishermen, and nationals of the countries who might be interested in undertaking the culturing of molluscs on a wider commercial basis,** the economic viability of the developed culture systems indicates that it will be profitable to culture molluscs for export.

In terms of transfer of the developed culture process, local economic and social conditions are key variables in project design and the successful development and transfer of technology. In this case, analysing cultural and economic practices, the ability of the target user to accept and absorb the technology, and the prevailing employment opportunities are necessary factors for the consideration of project design, areas of project research and other related project activities. For example: cultural practices in Malaysia and Singapore do not encourage high mollusc consumption; the technology developed in some projects is expensive and very different from already existing mollusc harvesting activities.

Though the evaluation did not focus on these issues specifically, visiting the projects and discussion with project personnel generated impressions which should be considered for future activities. Leadership qualities and motivation are very random variables which cannot be controlled but are especially crucial in countries where the local infrastructure is weak and access to scientific equipment and funds limited. These qualities are not as important in countries (such as Singapore) where conditions are conducive to research activities and infrastructure support is strong. The last factor, maintenance of

equipment, is a necessary aspect of any undertaking, and from project visits, this interest to maintain equipment in working order seems to be lacking.

FURTHER CONSIDERATION

4.7 Training

This area of project activities in our view was completely successful. In view of the needs of the projects, skills in socio-economic analysis, processing and marketing techniques are required for future activities in order for the projects to move beyond the research - experimental stages to production and sale of the molluscs. If hatcheries are considered to be an avenue for spat collection besides the natural way of collecting spat, training in hatcheries management would be required. The question is whether training would be provided in these areas to project personnel, or staff with expertise in this area be included in future project teams.

4.8 Networking

The potential to form network/s is there, especially when project recipients are expressing the interest to network. The commonality of research objectives provides the potential for networking. It would strengthen research skills and subject research conducted to a peer review analysis. Isolation of researchers would be alleviated. Considering the logistics of mounting a global network, a regional network would be more feasible.

ANNEX 1

Due to the length of the two questionnaires prepared for the evaluation, they are not reproduced in this document. The questionnaires are available from the Office of Planning and Evaluation, Ottawa, IDRC.

a) Oysterculture (Sierra Leone) Phase I 3-P-73-0080
Phase II 3-P-77-0146

The recipient and research institution of this project was the Fisheries Division, Ministry of Agriculture and Natural Resources, Government of Sierra Leone. The objective of Phase I was to conduct research on mangrove oysters of the genus Crassostrea in order to increase the potential yield and to establish a practical and economic system for their cultivation. The plan was to conduct scientific experiments on the growth of oysters utilizing different culture systems in the mangrove coastal areas of Sierra Leone. Prior to the project, there was no commercial culturing of oysters in Sierra Leone. In fact, according to the Phase II project summary, "virtually nothing was known about oysterculture in Sierra Leone". There was, however, harvesting of the wild mangrove oysters by local fishermen in the rural areas. The project leader was a Sierra Leonean, trained in marine biology (MSc). Initially, a Canadian expatriate had been assigned for two years (1974-1975) to the project to assist in the research activities. The project had consultancy visits and was monitored by AFNS fisheries and agricultural economics program staff. An economic analysis of the oysters produced was undertaken by the project staff with assistance from the agricultural economics group of AFNS.

Towards the end of Phase I of the project, a Phase II was proposed. The objectives of Phase II were to complete the scientific studies of Phase I and to undertake operational activities of involving village communities in the culturing of oysters.

b) Oysterculture (Jamaica) Phase I 3-P-76-0057
Phase II 3-P-77-0146

The recipient of this project was the Ministry of Agriculture, Government of Jamaica, who designated the Department of Zoology of the University of West Indies to coordinate and supervise Phase I of this project. The general objective of this project's Phase I is similar to the project in Sierra Leone : to conduct research on the mangrove oyster of the genus Crassostrea rhizophora for effective cultivation and to establish an economic and practical system of oysterculture. Prior to the start of the project, the University of West Indies had conducted preliminary investigations into the biological growth aspects of the mangrove oyster. Studies were also conducted by the Fisheries Division to collect oyster spat using a variety of substrates. The project leader was a faculty member of the Department of Zoology of the University of West Indies and a post doctoral research fellow was employed to assist in the biological studies. Phase I of the project had consultancy visits from two Canadian consultants and the project was monitored by AFNS Fisheries program staff. Pre-project training was also provided to a prospective staff member who was to join the project following completion of the training.

With the completion of Phase I, the Government of Jamaica submitted a proposal for Phase II of the project. Phase II is to enable the project recipient to refine the techniques developed to culture oysters and to enable the Government of Jamaica extension officers to demonstrate to prospective farmers the developed culture methods. At the time of the writing of this report, Phase II of the project has yet to be completed.

c) Oysterculture (Sabah) 3-P-74-0113

The institution which requested support for this project was the Department of Fisheries, Ministry of Agriculture, Government of Sabah. As a priority area, the culturing of oysters was identified at a regional aquaculture seminar held in Malaysia in 1973. Even before IDRC provided support to the Sabah Government for undertaking oysterculture research, preliminary trials on the growth of oysters had been carried out by the staff of the Fisheries Department of the Ministry of Agriculture. Furthermore, this interest of supporting oyster farming in Malaysia also is stated in the Third Malaysian Plan.

Prior to the start of the project, pre-project training was provided to the project leader. The objectives of the project were very similar to the projects in Jamaica and Sierra Leone : to conduct studies on the growth characteristics of mangrove oysters and the development of a practical method of culturing for possible transfer to the artisanal fishermen. As the project progressed, training was also provided to other staff members of the project. Besides the training of staff members of the project, the project had consultancy visits and was monitored by AFNS staff based in Singapore. The project was completed on June 30, 1981.

d) Musselculture (Singapore) 3-P-77-0121

Funds for this project were provided to the Department of Primary Production, the Government of Singapore. Prior to the funding of this project, the Department of Primary Production was conducting trials on the culturing of mussels and also biological experiments on mussels were undertaken at the University of Singapore. Because there had been some

initial research on the culturing of mussels in Singapore, project activities were directed not only on the environmental and growth aspects of culturing mussels, but there was also emphasis on the development of a production system and the associated post harvest aspects of producing mussels for food. Besides having had prior research experiences with mollusc culture, the project recipient also enjoyed the status of Singapore being identified as the site for an ASEAN mussel culture project by ASEAN experts in aquaculture.

The project activities included training for project personnel, and orientation visits for the project leader to visit processing plants in Europe to assess and review post harvest mussel technology. In addition, funds were provided to the project for design and fabrication of the post-harvest technology by a local engineering firm. The project also had monitoring visits by IDRC program staff and had technical consultancy visits by two IDRC consultants.

e) Oysterculture (Sudan) 3-P-77-0021

The project recipient for the above project is the Fisheries and Hydrobiological Research Section of the Agricultural Research Corporation, Government of Sudan. The main objective of this project is to provide economic opportunities for the fishermen in the area where the project is located. Prior to the provision of Centre funds, there were oysterculture activities in the north-eastern part of Sudan. As a result of oysterculture high mortality rates in 1973 and 1975, these activities were halted. A request for foreign assistance by the Sudanese Government to investigate the causes of the high mortality of the oysters and further support to undertake oysterculture activities led to the funding of this project by IDRC.

Unlike the other five projects being evaluated, the species of oysters to be cultured in this project were not for the production of food. Rather, it was cultured to produce oyster shells for the manufacture of buttons, etc. Other than this difference, the objectives of the project and its activities were similar to the other projects. Training was provided for project personnel and formal M.Sc. training enabled two of the project personnel to obtain their degrees. There were also consultancy visits prior to the start of the project and throughout the course of the project. It is anticipated that the recipient will request a Phase II.

f) Mariculture (Peru) 3-P-78-0090

For this project, the recipient is a university in Peru. The project leader is a professor in the Department of Fishculture and Oceanography, Universidad Nacional Agraria. Primarily, the objective of this project was to culture three species of mollusc, Aulacomya ater (brown mussel), Aequipecten purpuratus (scallop), and Mesodesma donacium (clam) for food. Like the other five projects, the aim was also to develop a production system suitable for transfer to the local fishermen and to train these fishermen in the new culture techniques.

According to the project summary, the project personnel, the project leader and his assistant had prior experiences in mollusc cultivation. Pre-project orientation training was also provided to project personnel by an IDRC consultant. Orientation visits to Europe were made by the project leader and his assistant to familiarize themselves with the culture techniques of molluscs undertaken in Europe. Monitoring visits of the project were also made by the fisheries program staff of AFNS.

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The following tables are abstracted from a consultancy report, An Evaluation of the Viability of the Oyster Culture Project at Tawan, Sabah, prepared by two Malaysian consultants on contract to IDRC. In reviewing the tables, the reader should take note of the footnote on page 50.

Table 3

Benefit-Cost Analysis for Oyster Culture Project *

Measure of project worth		0.25 acre culture plot	0.5 acre culture plot	1 acre culture plot
Net Present Value	Discounted at 10%	\$10574.80	\$21255.43	\$42512.59
	Discounted at 15%	\$ 7864.04	\$15813.91	\$31627.8
Benefit Cost Ratio	Discounted at 10%	1.66	1.66	1.66
	Discounted at 15%	1.57	1.57	1.57
Internal Rate of Return (IRR)		55	55	55

* Details of how these figures were obtained are shown in Appendix 1, 2 and 3.

Table 4

Cash Flow for quarter acre oyster culture project for
one production period (12 months)

Item	Project Year										
	0	1	2	3	4	5	6	7	8	9	10
<u>Inflow</u>											
Revenue from sale of 7,200 oysters	0	4320	4320								4320
<u>Outflow</u>											
TOL	12.50										12.50
Spat collectors (1,500)	1814.40			1814.40			1814.60			1814.60	
Spat trays (63)	630			630			630			630	
Rack construction (30)	1650										
Culture trays (90)	900			900			900			900	
Miscellaneous	90										90
Labour		720									720
Total Outflow	5096.9	822.5	822.5	4166.9	822.5	822.5	4166.9	822.5	822.5	4166.9	822.5
Net Cashflow	-5096.9	3497.5	3497.5	153.1	3497.5	3497.5	153.1	3497.5	3497.5	153.1	3497.5
Bank loan	5096.9										
Loan repayment	0	509.69									509.69
Interest payment	0	509.69	458.73	407.75	356.78	305.81	254.85	203.88	152.91	101.94	50.97
Cash flow after financing	0	2478.12	2529.08	-704.25	2631.03	2682	-611.44	2783.93	2834.9	-458.53	2936.84

Table 5

Cash Flow for half acre oyster culture project
(production period, 12 months)

Item	Project year										
	0	1	2	3	4	5	6	7	8	9	10
Inflow											
Revenue from sale of 14,400 oysters		8640	8640								8640
Outflow											
TOL	25	25	25								25
Spat collectors (3,000)	3600			3600			3600			3600	
Spat trays (125)	1250			1250			1250			1250	
Rack construction (60)	3300										
Culture tray (180)	1800			1800			1800			1800	
Miscellaneous	180	180									180
Labour		1440									1440
Total outflow	10155	1645	1645	8295	1645	1645	8295	1645	1645	8295	1645
Net cash flow	-10155	6996	6996	345	6995	6995	345	6996	6996	345	6995
Bank loan	10155										
Loan repayment	0	1015.5									1015.5
Interest payment	0	1015.5	913.95	812.4	710.85	609.3	507.75	406.2	304.65	203.1	101.55
Cashflow after financing	0	4964	5065.55	-1482.9	5268.65	5370.2	-1178.25	5573.3	5674.85	-873.6	5877.95

Table 6

Cash flow for one acre oyster culture project
(production period, 12 months)

Item	Project year										
	0	1	2	3	4	5	6	7	8	9	10
<u>Inflow</u>											
Revenue from sale of 28,800 oysters		17280									17280
<u>Outflow</u>											
TOL	50										50
Spat collectors (6000)	7200			7200			7200			7200	
Spat trays (250)	2500			2500			2500			2500	
Rack construction	6600										
Culture trays (360)	3600			3600			3600			3600	
Miscellaneous	360										360
Labour		2880									2880
Total outflow	20310	3290	3290	23190	3290	3290	23190	3290	3290	23190	3290
Net cash flow	-20310	13990	13990	-5910	13990	13990	-5910	13990	13990	-5910	13990
Bank loan	20310										
Loan repayment	0	2031									2031
Interest payment	0	2031	1827.9	1624.8	1421.7	1218.6	1015.5	812.4	609.3	406.2	203.1
Cashflow after financing	0	9928	10131.1	-9565.8	10537.3	10740.4	-8956.5	11146.6	11349.7	-8347.2	11755.9

Table 7

Sensitivity analysis with a fall in price of 20 and 50 per cent and a rise in mortality rate to 30 and 50 per cent for a 0.5 acre culture plot

Change in variable	Net Present Value		Benefit-Cost Ratio		Internal Rate of Return
	Discounted at 10%	Discounted at 15%	Discounted at 10%	Discounted at 15%	
20 per cent fall in price per oyster	\$10640	\$7141	1.33	1.26	> 30%
50 per cent fall in price per oyster	-\$5288	-\$5867	0.83	0.79	≈ 7%
Mortality rate of 30 per cent	\$14621	\$10394	1.46	1.37	> 30%
Mortality rate of 50 per cent	\$1349	-\$447	1.04	0.98	≈ 10.3%

APPENDIX 1

Benefits and Costs for a 0.25 Acre Oyster Culture Plot

	year											Total	NPV (\$)	B-C Ratio	IRR(%)
	0	1	2	3	4	5	6	7	8	9	10				
Benefits	0	4320	-----	-----	-----	-----	-----	-----	-----	-----	4320	43200	19844.5	1.85	
Costs	5069.9	822.5	822.5	4166.9	822.5	822.5	4167.1	822.5	822.5	4167.1	822.5	23355.5			
Benefits discounted at 10%	-----	-----	-----	4320 x 6.1446	-----	-----	-----	-----	-----	-----	-----	26544.67	10574.8	1.66	55
Costs discounted at 10%	5096.9	747.73	679.71	3130.59	561.77	510.69	2352.33	422.11	383.70	1767.27	317.07	15969.87			
Benefit discounted at 15%	-----	-----	-----	4320 x 5.0188	-----	-----	-----	-----	-----	-----	-----	21681.22	7864.04	1.57	
Costs discounted at 15%	8096.9	715.25	621.89	2739.74	470.22	408.95	1801.44	309.18	268.88	1184.71	203.32	13817.18			

APPENDIX 2

Benefits and Costs for a 0.5 acre Oyster Culture Plot

	YEAR											Total	NPV	B-C Ratio	IRR(%)
	0	1	2	3	4	5	6	7	8	9	10				
Benefits	0	8640	-----	-----	-----	-----	-----	-----	-----	-----	8640	86400	39845	1.85	
Costs	10155	1645	1645	8295	1645	1645	8295	1645	1645	8295	1645	46555			
Benefits discounted at 10%	-----	-----	-----	8640 x 6.1446	-----	-----	-----	-----	-----	-----	-----	53089.34	21255.43	1.66	55
Costs discounted at 10%	10155	1495.47	1359.4	6232.03	1123.54	1021.38	4682.53	844.21	767.39	3518.91	634.15	31833.91			
Benefits discounted at 15%	-----	-----	-----	8640 x 5.0188	-----	-----	-----	-----	-----	-----	-----	43362.43	15813.91	1.57	
Costs discounted at 15%	10155	1430.49	1243.78	5453.96	940.45	817.89	3585.93	618.36	537.75	2358.27	406.64	27548.52			

Appendix 3

Benefits and Costs for a 1 Acre Oyster Culture Plot

	YEAR											Total	NPV	B-C Ratio	IRR(%)
	0	1	2	3	4	5	6	7	8	9	10				
Benefits	0	17280	-----	-----	-----	-----	-----	-----	-----	-----	17280	172800	79690	1.85	
Costs	20310	3290	3290	10590	3290	3290	16590	3290	3290	16590	3290	93110			
Benefits discounted at 10%	-----	-----	-----	17280 x 6.1446	-----	-----	-----	-----	-----	-----	-----	106178.69	42512.59	1.66	55
Costs discounted at 10%	20310	2990.94	2718.86	12464.07	2247.07	2042.76	9365.06	1688.43	1534.79	7035.82	1268.30	63666.1			
Benefits discounted at 15%	-----	-----	-----	17280 x 5.0138	-----	-----	-----	-----	-----	-----	-----	86724.86	31627.8	1.57	
Costs discounted at 15%	20310	2860.98	2487.57	10907.93	1690.89	1635.79	7171.86	1236.71	1075.50	4716.54	813.29	55097.06			

INTERVIEW SCHEDULE

Canada

Dr. Dan Quayle, IDRC consultant, Nanaimo, British Columbia.

Sabah, Malaysia

Mr. Joseph Wong, Director of Fisheries, Government of Sabah.
Mr. Chung Chee Piao, Fisheries Officer, Government of Sabah.
Mr. Zephrein Wong, Fisheries Officer, Government of Sabah.
Mr. Yong Foong Chuan, Fisheries Officer, Government of Sabah.
Mr. Lim Aun Luh, Former Project Leader,
Syarikat Pelihara Udang Sdn. Bhd., Tawan, Sabah.

Singapore

Mr. Leslie Cheong, Project Leader, Dept. of Primary Production,
Govt. of Singapore.
Mr. Robert Lee, Asst. Director, Dept. of Planning Production,
Govt. of Singapore
Mr. Lee Hoe Beng, Fisheries Officer, Dept. of Primary Production,
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Mr. Yap How Keong, Mussel farmer, 36, Boon Teck Road, Singapore.

Peru

Mr. Victor Venturi, Project Leader, Universidad Nacional Agraria.
Mr. Hugo Nava, Associate Project Leader,
Universidad Nacional Agraria

Jamaica

Mr. Lawrence Alexander, Project Leader, Ministry of Agriculture,
Government of Jamaica.
Dr. Barry Wade, Former Project Leader, Director,
Petroleum Corporation of Jamaica
Mr. Carl Hanson, Fisheries Officer, Govt. of Jamaica.
Mr. Bertie Lopez, Fisheries Officer, Govt. of Jamaica.
Mr. Alfred Singh, Extension Officer, Govt. of Jamaica.

Sudan

Mr. T.T. George, Former Project Leader, ARC.
Mr. Osman Saeed, Project Leader, ARC.
Dr. Sayed Mohd Ali, Fisheries Scientist, ARC.
Dr. Mohd Saeed, Director General, ARC.

Sierra Leone

Mr. Abu Kamara, Project Leader, Ministry of Natural Resources.
Mr. Mohamed Sheriff, Fisheries Officer, Ministry of Natural
Resources.

Mr. P. Deigh, Permanent Secretary, Ministry of Natural Resources.

Mr. A. H. Robbie, Processing Officer, Ministry of Natural
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Chris MacCormac, Program Officer, AEG, AFNS.
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