Description of Problems
Problem Specifications and Targeting
Current Status and Prospects
Desirable Linkages
Expected/Intended Results

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FISHERY DEVELOPMENT SUPPORT SERVICES
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SOCIO-CULTURAL FACTORS

FISHERIES MANAGEMENT AND RESOURCE UTILIZATION

USE OF MARICULTURE IN DEVELOPING COUNTRIES

POST-HARVEST FISHERY LOSSES

ICMRD

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INTRODUCTION

Under USAID Cooperative Agreement DAN 4024 A-00-2072, "Fishery Development Support Services," Working Committees (see below) have produced this document. After identifying the four priority areas, committees were formed to prepare the following:

Description of Problems
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Current Status and Prospects
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TABLE OF CONTENTS

SOCIO-CULTURAL FACTORS

1. Description of Problem Reviews of small-scale marine fishery development projects in many parts of the world (see Emmerson 1980, Smith & Peterson 1982, Berleant-Schiller 1982, Christensen 1982; Pollnac 1985, 1982, 1981) have indicated that many result in failure despite their apparent technological adequacy. Frequently, "human factors" are listed among the reasons for failure; e.g., reluctance to use the new technology, improper use of the techniques, rejection of the new product, active violation of management rules, etc. In most cases these "human factors" are vaguely defined and the result of post hoc interpretation of qualitative, as opposed to quantitative project data. Since "human factors" are involved in practically all aspects of increasing fishery production and the quality of life of those involved in cultivating, harvesting, processing, and distributing marine fishery products, it is essential to approach their study in a more systematic manner.

The Problem: Lack of a systematic understanding of the human impediment to fishery development.

Scope of the Problem A consideration of human (e.g., social, cultural, and psychological) impediments to the transfer of appropriate fisheries technology and institutions.

- For the most part, marine fishery development projects involve humans residing and working in the coastal zone both on the land and the water. This environment and its products have placed specific demands on the technologies and techniques used in its exploitation. In turn, these technologies and techniques have placed demands on the social and cultural systems of the humans living in and exploiting the products of the coastal zone. Although different societies have found different ways of coping with the demands of extracting a living from the coastal zone, these ways vary within a range of possibilities, some of which are unique to this specific ecological niche (see numerous papers by Pollnac, Poggie, and others). Although some beginnings have been made in terms of relating our understanding of this general problem to development issues (this will be specified below in the section on current status), there is still a long way to go before we can consider this analysis as being complete.

a. We need to know more concerning traditional behavior patterns in "fishing"[1] communities.

b. Associated with "a" above, we need to know more about the traditional distribution of labor (e.g., between age groups, ethnic groups, sexes, etc.) in fishing communities.

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[1] From now on, "fishing" will refer to all fishery related activities.

c. We need to know more about traditional institutions in fishing communities.[1]

d. We need to determine the interrelationships between the sociocultural characteristics[2] of fishing communities, their technology and techniques, and specific aspects of the marine environment and coastal zone. This will allow us to separate those which are related to maritime adaptations from those which are related to other variables.

- Specific sub-problems involve a need for developing a system for applying facts concerning both general and specific sociocultural characteristics of fishing communities to improve our abilities to ameliorate human factors contributing to (1) post-harvest loss of up to 40 percent of catch, (2) poor utilization of total catch, (3) the inability of developing countries to effectively manage their fisheries in the near shore environment, and (4) the low use of mariculture in developing countries.

- With respect to post-harvest loss and poor utilization of total catch, we need to develop our understanding of the sociocultural factors which result in differing levels of resistance to or inability to cope with the technological changes among fishermen, processors, distributors, and retailers of fishery products. Sociocultural factors resulting in resistance to new products, processing, and/or packaging also need elucidation.

- Effective management also encounters human impediments. It is essential that we increase our understanding of factors that impede cooperation of members of the fishing community when their inputs are needed for stock assessment data. Further, a lack of understanding of sociocultural impacts of alternative management strategies also impedes management, since fishing community members who perceive the plan as somehow "unfair" will simply refuse to cooperate.

- Regarding the low use of mariculture in developing countries, we need to develop our understanding of the sociocultural factors which result in resistance to or failure of the practice in fishing communities.

2. Problem specifications and targeting

- With regard to assessments and evaluations of practically all development projects (irregardless of agency), there is at least "lip-service" paid to "human," "sociocultural," and/or "socioeconomic" factors.

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[1] For the social science reader, a through c above is written for the general reader. It could be condensed into "sociocultural characteristics" and actually mean a great deal more, as well as being more precise, but we must consider the audience.

[2] This includes "a", "b", and "c" above.

- Anthropologists at URI (Poggie and Pollnac) have conducted research and published papers dealing with all of the above stated problems and subproblems. They are, of course, a limited resource. Dr. Albert (sociologist) is beginning to develop a competency in this area.

- The general problem of systematically relating sociocultural aspects of fishing communities to fishery development problems should be financed first. This would be followed by the systematic application of these findings to other specific problem areas.

3. Current status and prospects

- The baseline data include:

a. A long list of specific publications by Poggie and Pollnac (these can be specified if necessary).

b. A cross-cultural sample (now on a data set) coded for degree of emphasis on fishing as well as numerous other sociocultural (and technological) variables. The sample includes 186 societies from all major world areas.

c. Another cross-cultural sample (on a data set) of 146 societies who depend for 30 percent or more of their subsistence on fishing. This data set also includes codings for a wide range of sociocultural data.

d. Numerous (exact number probably close to 50 or 60) dissertations have been ordered and are now on file in the ICMRD library which deal with sociocultural aspects of specific fishing communities around the world. The ICMRD library and main library holdings include numerous books containing social and cultural information on fishing communities.

e. Field notes and data sets (compiled from data collected in developing and developed fishing societies) in the personal files of Pollnac and Poggie. These data sets contain data from Africa, Latin America, the Azores, New England, and the Philippines.

- The above-listed baseline data can be analyzed by ICMRD anthropologists and converted into specific recommendations concerning amelioration of human impediments to fishery development. Additionally, gaps in available information can be identified and proposals developed for obtaining more data.

- Prospects for support include new emphasis by AID on fishery development in West Africa and Ecuador.

4. Desirable linkages

- Already established with World Bank and FAO.

- Dr. F. Carmo, University of Azores
  Dr. R. McGoodwin, University of Colorado - Boulder
  Auburn Aquaculture Program
  Woods Hole Oceanographic Institution MPOM

5. Expected/intended results

- More than 40 Anthropology Working Papers, numerous professional publications, several ICMRD Working Papers, and a guide dealing with human factors in fishery development have been and are being distributed by the ICMRD Information Service. This has generated significant interest.

- Guides dealing with fishermen's organizations and sociocultural variables in the fishery project cycle are in draft form and will soon be completed. Some training programs have been developed and carried-out with Bureau of Fisheries and Aquatic Research personnel from the Philippines. Further research can be conducted in conjunction with other major problem areas (e.g., post-harvest loss, mariculture, etc.).

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4

FISHERIES MANAGEMENT AND RESOURCE UTILIZATION

Description of the Problem

It has become clear in recent years that the fisheries of the developing countries in many parts of the world are in as great or greater need of management than are the fisheries of developed countries. Attention has been focused on this need by the recent extensions of jurisdiction at sea to two hundred miles even though serious need existed prior to the changes in the law of the sea. The small-scale fisheries in many areas had seriously overexploited coastal reef and other demersal resources. This despite the fact that the fishing gear and methods were not modern in some sense.

The management of fisheries is of particular importance to the developing countries for a variety of reasons, among which are:

1) to prevent declines in the output of the fisheries sector,

2) to increase the output from the sector,

3) to assure that the developing countries benefit fully from exploitation of their fisheries, and

4) that the small-scale fishermen and the poor consumers share in these benefits.

While the need for fisheries management is clear, it is equally clear that most developing countries are unable to manage their near-shore and offshore fisheries with each of these kinds of fisheries presenting special problems of its own.

Exacerbating the problems of fisheries management and generating problems in its own right is the vexing issue of the failure to utilize, fully, the catches of important sectors of the fishing industry. This problem arises in a number of ways. Of great importance in many countries is the failure to use the incidental catches of major fisheries such as those for shrimp. These catches may amount to as much as twenty tons of fish for every ton of shrimp caught. In other countries this incidental catch may be of juveniles of valuable species which are either disposed of at sea or may be directed to very low value uses such as fertilizer.

In any event, the fact of the catches themselves presents problems to fisheries managers, since very little information is available about the amount and composition of these catches in particular fisheries. Moreover, since these catches are not the result of a directed fishery but incident upon the prosecution of other fisheries, they are difficult to control and very difficult to manage.

Equally important, and of particular importance to consumers, is the failure to utilize the resource once it has been captured. This presents both technical and economic issues that must be addressed. The

catches are not retained for later sale or find their way into low value uses because it is not economically feasible to do otherwise in the circumstance.

Problem Specification

The inability of developing countries to manage their fisheries resources has its roots in four critical problem areas. These are:

1. The lack of appropriate analytical methodologies of several kinds, among which are:

    a. Methods and techniques of stock assessment

    b. Methods of evaluating the economic impacts of management on:

        - the fishing community
        - the consumers
        - the local economy and hinterland

2. The lack of adequate data (or the lack of an appropriate information system) which is closely linked to the points noted in 1. above.

3. A poor or nonexistent management infrastructure. While fisheries regulations have been promulgated in many developing countries, these have often been ad hoc responses to some circumstance. These responses frequently have no relevance to the real problem of management for which the supporting analytic and administrative infrastructure has never been developed.

4. The high costs of monitoring the performance of the fisheries sector, whether it is managaed or not. The high cost of conventional information systems inhibits their development (See 2. above), and new systems need to be designed and tested.

Recognition of the Problem

The need for the management of fisheries resources has long been recognized in the professional community and more lately by many of the more important fishing nations. Only recently have development agencies recognized that fisheries development without consideration of management may imperil the resources themselves.

Increasingly, developing countries have begun to look to the management of their fisheries resources as being necessary to maintaining the long run flow of benefits from these resources. In many cases management has been simplistically perceived as a matter of regulating offshore foreign operations in order to extract appropriate payments. While the need to manage the nearshore resources may be recognized, the difficulty of doing so is appreciated as well. The large numbers of low income people involved in the coastal fisheries presents particular problems for many developing countries in addressing questions of fisheries management.

The Current Status of University Work in the Area

There has been a long history, at the University, of work on the problems of fisheries management and the utilization of fishery resources. Management research efforts have long been pursued at the Graduate School of Oceanography under the leadership of Prof. Saila and have addressed a wide range of developing country problems. A major current effort in the realm of management is now being conducted under the auspices of the Stock Assessment CRSP.

Within the Department of Resource Economics research in fisheries management and development has been underway for more than twenty years, and much of that on the problems of developing countries. The management-related efforts in both parts of the Univeristy have been collaborative and in many cases under the sponsorship of ICMRD. Recently this nuclear group has been augmented by the Department of Fisheries and Marine Technology in providing sound bases for management research in both biology and economics.

In the domain of utilization, the Department of Food Science and Technology has provided the leadership in technological matters, with the Department of Resource Economics having been involved in market development and cost assessment in expanding the utilization of fish since the mid-1960's. The Department has recently expanded its commitment to fisheries marketing and utilization issues with the addition of a faculty member with full commitment to marketing issues.

With the large numbers of people dependent upon the the coastal fisheries in developing countries, the human impediments to management as well as the consequences of management in human terms have long been recognized at the University in the continuing contribution of the social scientists to almost every project. The importance of the human issues in fisheries management dictates continued attention to these problems.

Linkages

The linkages of the University with other institutions and organizations in the fields of fisheries management and utilization are myriad. For more than twenty years the University has worked in collaboration with FAO on these matters. In addition, there are links with research organizations in Germany, France, Spain, Brazil, Chile, Malaysia, Indonesia, the Philippines, Japan, Thailand, the U.K. and Canada. These include the SEAFDEC, ICLARM, FRBC, ORSTOM and FSLB, to name just a few. Among the University linkages are The University of the Philippines (Los Banos, Leganes, and Quezon City), The Universiti Malaya, the University Pertanian Malaysia, Kasetsart University (Thailand), the Institut Pertanian Indonesia (Bogor), The University of Costa Rica, The Nacional University of Costa Rica, The Catholic University of Valparaiso, The University of Concepcion and many others.

Expected Results

The results of the effective collaboration between the ICMRD scientists and the developing country counterparts should produce several usable management models for use in tropical multispecies artisan fisheries. A supporting information system will also be designed. These models will be prepared for pilot testing and experimentation.

In the area of resource utilization several pilot technologies would have been designed, and the related market analysis would have been completed. Prototypes would remain to be contructed and tested.

USE OF MARICULTURE IN DEVELOPING COUNTRIES

1. Description of the Problem

Fish farming is not a new idea, as it has been practiced for over 2,000 years. Nevertheless, aquaculture or mariculture production represents only a fraction of the fish which are caught in traditional fisheries. Aquaculture has and will increase in importance for several reasons:

A) the fear that marine pollution and overfishing will deplete stocks;

B) the coastal, estuarine and inland waters are the only areas in which a country can exercise control of the fishery;

C) like agriculture, the management can be planned and controlled at each level; and

D) the introduction of new species, technology, export markets and capital has made mariculture popular.

Aquaculture more closely resembles agriculture than it does commercial fishing. Both assume that the proper management of conditions should yield more and better products. Aquaculture fish must, however, compete in price and quality characteristics with the caught product, and with few exceptions, the standard of identity - size, shape, color, taste, etc. - is established by the fishery product. An increasing number of species are now being cultured egg to egg, and thus the promise is great. Unfortunately, fish culture operations have to be considered high-risk ventures due to a number of factors. Aquaculture is an integrated business, and where the integration has been broken, the failure risk is high. Pollnac et al (1982) list some decision points in implementing an aquaculture industry (Fig. 1). We would add the cost of energy and the export of inappropriate technologies to developing countries to their list, and we suggest that some cultivation procedures which rely on high water and energy usage, high protein feed, disease-free culture, sophisticated equipment, etc., are especially high risk. Nevertheless, venture capital is available, certain species are in demand, and it is in the national program to raise shrimp, etc.

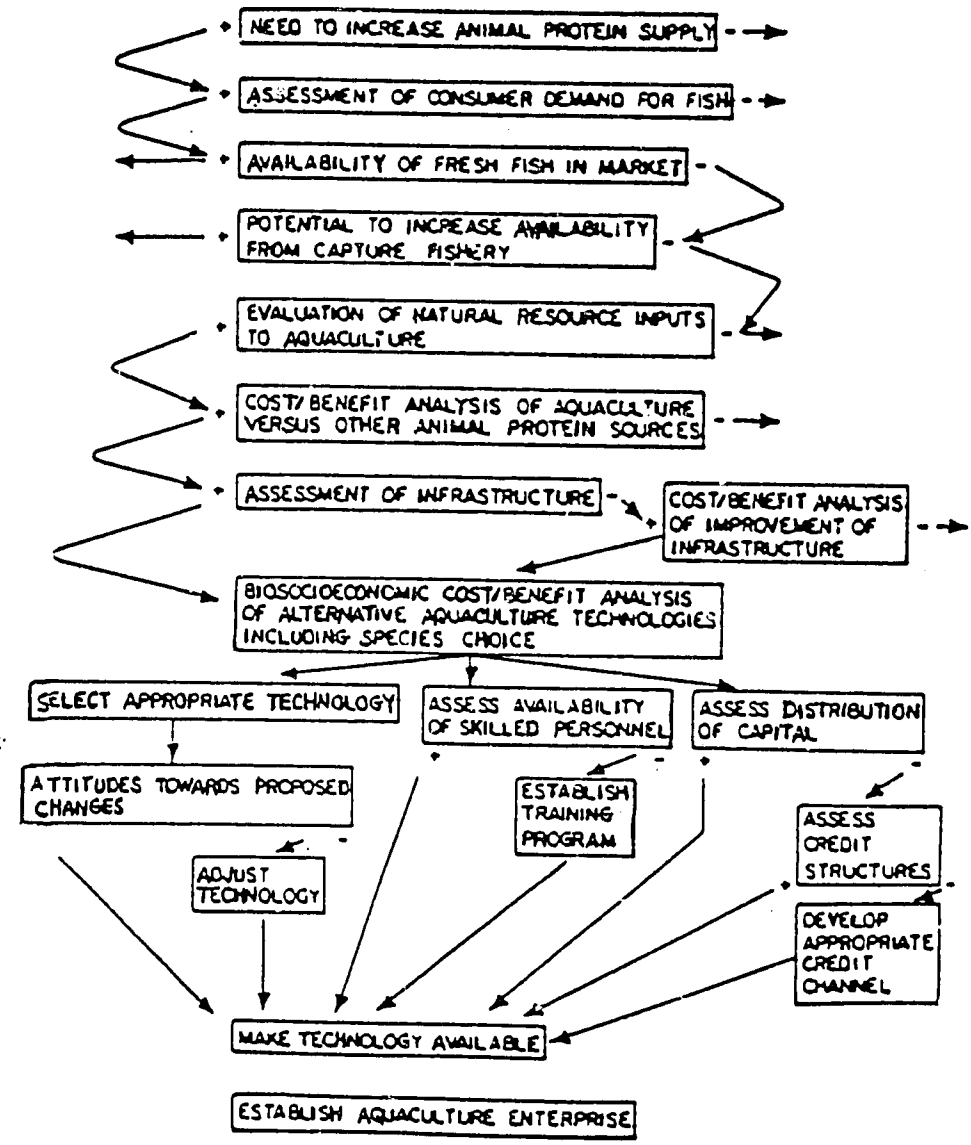
2. Problem Specification and Targeting

Formerly, mariculture operations depended on the harvest of larval shrimp, milkfish, etc. for their growth at production facilities. This meant that the prices tended to be high due to transportation and stock costs. In addition, this procedure placed them in direct competition with the capture fisheries. On the other hand, the egg to egg culture still has some problems in induced spawning and the larval food. The latter problem is particularly serious. The state of the art still requires phytoplankton and zooplankton to be fed to critical life phases. Mortalities can be prohibitively high, unless Artemia nauplii

are available. This represents a key bottleneck, since the price is high and the supply variable in both quality and quantity. Recently, encapsulated diets have shown promise as Artemia replacements, but unless they are fabricated in-country, the price would be prohibitive.

Figure 1

Decision Points in Implementing Aquaculture



AID Interest	Other Donors
Artemia culture	IFS, Sea Grant, NOAA, FAO UNDP, SEAFDEC
Shrimp production	NOAA FAO, UNDP
Milkfish culture	ICLARM, SEAFDEC
Disease vectors	Sea Grant
Water quality	Sea Grant, EPA
Breed selection	
Aquacultural economics	Sea Grant
Sociological aspects	Sea Grant
Training	
University of Rhode Island Interest	
Artemia culture and quality	Title XII, EPA, Sea Grant, SEAFDEC
Shrimp production	Title XII
Larval fish diet/encapsulation	Sea Grant, EPA, NOAA
Pathology	Sea Grant
Water quality	Sea Grant, EPA
Sociological/anthropology	CA, Title XII, see other

URI has maintained a solid research base with Sea Grant and EPA funding. The focus, however, in these studies is on domestic rather than international problems. There is a need to provide assistantships to foreign students who will research problems in critical areas and return to head up operations in the LDC's. URI also has had experience in directing M.S. or Ph.D. degree research in the LDC.

3. Current Status and Prospects

3-1 Hatchery Production of Shellfish Seed-Stocks for Mariculture in Developing Countries

A reliable and continuous supply of healthy seed-stocks of the selected shellfish species is essential for success of mariculture in the developing countries. Shellfish seed-stocks may be obtained from collecting juveniles in nature, or by artificial cultivation from eggs and larvae under controlled conditions in hatcheries. The hatchery method of seed-stock production has many advantages for both practical and economic reasons, but it requires that technically trained personnel are available for daily maintenance and operation. Information and technology transfer for the construction of hatcheries in developing countries, and technical training and education of personnel for the operation and maintenance of the hatcheries, can contribute towards a rapid development of mariculture for profit or protein. Hatchery method of seed-stock production has also the advantage for later improvement of seed-stock strains by selective breeding and by genetic engineering. Two groups of shellfish, the bivalve mollusks and the crustaceans, are particularly well suited for hatchery production of seed-stocks and for mariculture in the developing countries. The basic principles in

hatchery design and construction and maintenance and operation are the same for both the groups (Fig. 2), but the details of the procedures employed in cultivation are different.

Three major problem areas are recognized for the establishment and operation of shellfish hatcheries in developing countries:

I. Design and construction of the hatcheries

II. Operation and maintenance of the hatcheries

III. Availability of technically trained personnel for maintenance and operation

The components of the three problem areas are listed below:

A. Design and construction of the hatcheries

1. Site selection

2. Plant Design

a. Facilities for collection and maintenance of the brood stock

b. Facilities for the production of food organisms

c. Facilities for the cultivation of eggs/larvae for the production of seed-stocks

d. Facilities for holding seed-stocks prior to transplantation to grow-out systems.

3. Sea water supply

a. Sea water pumping, storage and distribution

b. Plumbing sea water distribution systems

c. Sea water quality maintenance by filtration and purification

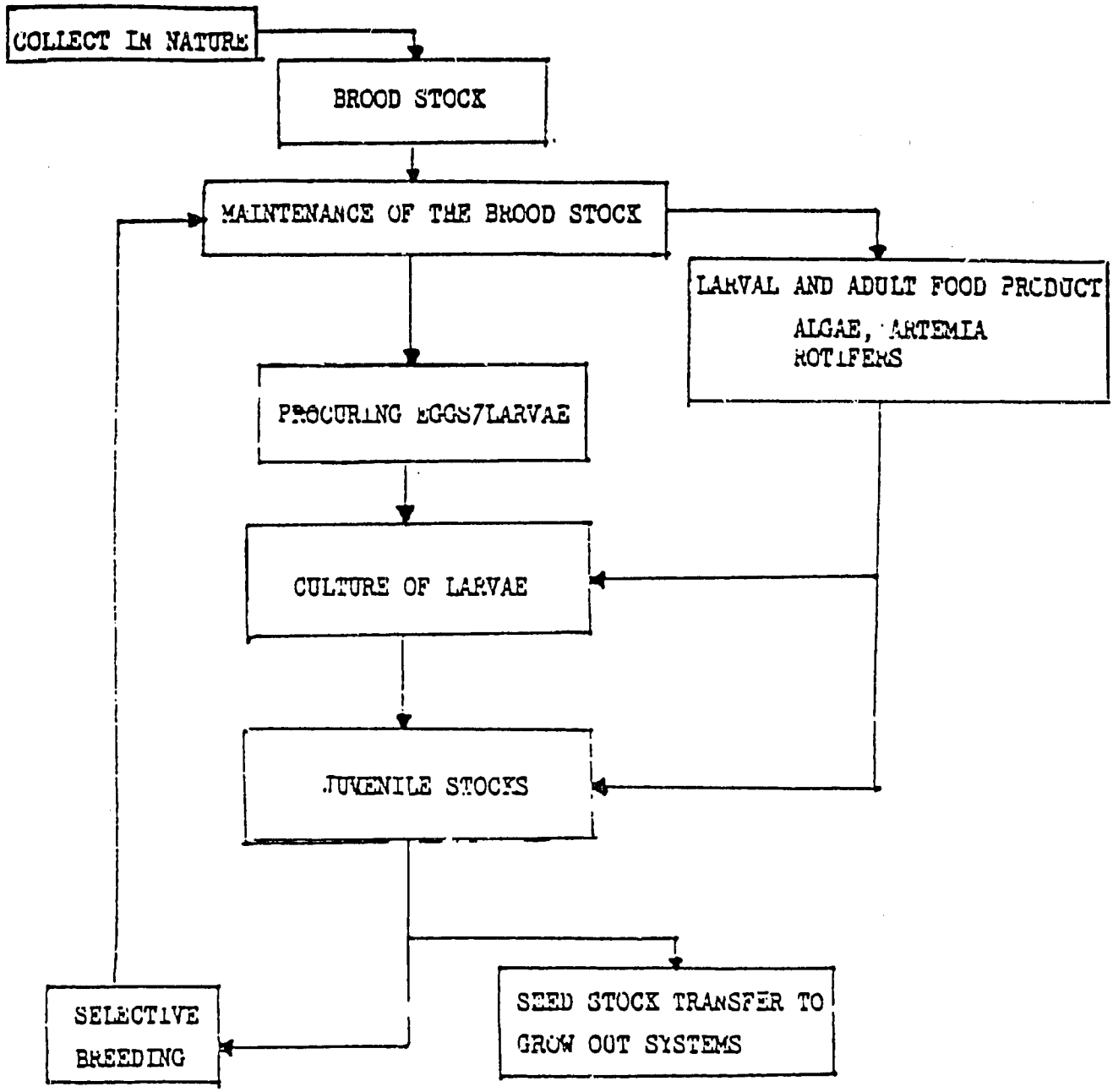
d. Tanks and containers for culture and holding food organisms, seed-stocks, and brood stocks

B. Food Production for larvae, seed-stocks and brood-stocks

Bivalve (oysters, clams and mussels) larvae grow well on a variety of unicellular algae that can be grown in large quantities in continuous cultures on enriched media. Crustacean larvae grow well on a diet of freshly hatched brine shrimp Artemia nauplii that can also be readily obtained from the hatching of eggs. Rotifers are also suitable as food for crustacean larvae, and they can be grown in large quantities employing the artificial cultivation techniques. Just as seed-stock

Figure 2

Hatchery method of shellfish seed-stock production



production is important to the overall success in mariculture, the production of food organisms on a reliable and continuous basis is equally important for a successful hatchery production of the seed-stocks. Hence, the food production facility is a key element in the establishment and maintenance and operation of the hatcheries. The techniques for large-scale production of algae, brine shrimp and rotifers are readily available. The following problem areas need to be considered in adaptation of the techniques and procedures of food production as a component of the hatcheries.

1. Unicellular food production

    a. Sea water filtration and sterilization
    b. Media preparation
    c. Materials for construction of food production facility
    d. Artificial or natural light sources
    e. Facilities for the maintenance of algal stocks
    f. Algal culture tanks
    g. Environmental control for optimal growth conditions

2. Brine shrimp Artemia nauplii food cultures

    a. Source and supply of eggs of an acceptable quality
    b. Facility for hatching of the eggs and separation of nauplii

3. Rotifer food cultures

    a. Stock cultures
    b. Large-scale culture facility

C. Larval culture for juvenile production

1. Methods and techniques for procuring eggs and larvae
2. Facilities for the maintenance of larval cultures
3. Environmental control for optimal culture conditions
4. Design of culture tanks
5. Techniques for spat or juvenile harvesting
6. Juvenile holding facilities prior to transplantation

D. Selective breeding program for improving the seed-stocks

1. Controlled reproduction
2. Hybrid performance

IV. Operation and maintenance

1. Technical training and education of personnel
2. Development of manuals and guides for hatchery maintenance and operation.

3-2 Establishment of a Shrimp Hatchery

The developmental outline of an integrated shrimp mariculture project is summarized below.

The most promising enterprise(s) based on results of a marketing study should be evaluated in a feasibility study from a cash flow point of view. Questions which will be addressed include:

Can a fish/shrimp hatchery and/or tambak be built and operated at a cost which will result in a positive cash flow? Will the interest on an equal amount of money be sufficient to buy more fish/shrimp than the farm will produce?

Specific decision points:

A. Assist developing country group in the design, plan, implementation and evaluation of the marketing studies in U.S., Japan and in-country.

B. Conduct a reconnaissance survey, to evaluate the practicality, summarize the potential and make recommendations for development.

C. Finalize Site Selection

   1. Examine proposed site(s) for suitability:

      a. Assess topography

      b. Physical/chemical characteristics of water, soil and algae.

      c. Collect and analyze records of climate conditions

   2. Recommend most suitable construction plan

   3. Investigate facilities for processing (cysts and/or tails)

   4. Ascertain and analyze local resources and logistics

D. Feasibility Study

   1. Prepare an economic analysis of production of most appropriately configured enterprise under various assumptions and conditions.

E. Develop plan for overall activities, budget for pilot scale and step-wise plan for complete development

   1. Train in-country personnel on-site during the project and at URI/CSCI when necessary.

F. Assist ongoing project where necessary with improvements to enhance effectiveness.

3-3 Fin Fish Culture

In keeping with the AID Cooperative Agreement philosophy of aiding the marginal or poorer elements of society, this discussion focuses on low-cost fish. Two types of marine fish are particularly important in this regard: mullet (Mugil spp.) and milkfish (Chanos chanos) are both herbivorous and can be raised in shallow, brackish-water ponds. Herbivory is the key to productivity because farmers need only add fertilizer to the system to insure adequate food (e.g., blue-green algae), and feeding directly on the primary producer trophic level means that relatively little energy is lost in trophic level transfer compared to the energy lost if three or four trophic levels were involved (approx. 90 percent loss of energy with each trophic level transfer).

Since brackish water is required, the ponds must be situated along the coast near a river, so that both sea water and fresh water are available. The basic elements are:

A. availability of suitable land, which can be either rented or purchased,

B. availability of suitable water,

C. capital investment for construction of ponds,

D. availability of fry for stocking ponds,

E. expertise for management of the system,

F. input of fertilizer and materials to counter parasites/disease

G. harvest/transport/marketing of product

Mullet farming has been successful in Israel and Italy and milkfish farming in Indonesia, Philippines and Taiwan (among other places). Although the political-economic systems, degree of government involvement, and level of sophistication of the enterprise vary from place to place, some common problems and solutions exist.

A. Coastal land, often in the form of mangrove swamps, may be privately owned or under government control. In either case, considerable alteration of the habitat is probably necessary and some guarantee of long-term usage potential is necessary before anyone will begin to clear the land and build ponds. If government-owned, a long-term lease at very cheap rates should be arranged.

B. The availability of both salt and fresh water of adequate quality (i.e., low levels of pesticides) that can be pumped or tidally-flushed into the ponds is necessary. The requirement of siting the mariculture enterprise at the outflow of a river into the salt water means that the fresh water probably contains all the pollutants dumped into the river during its course. Another aspect is that siting and pond construction

should minimize flood potential, whether from the river (excessive rains) or from the sea (excessive tides), or the entire crop of fish can be washed away in a few hours.

C. One of the costliest parts of a mariculture operation is pond construction, which involves everything from clearing land to digging ponds to building dikes. A large source of capital must be available and may be difficult to obtain for a crop of low-cost fish to feed the poor. If only profit levels are considered, the capital may very well be unavailable; thus, public welfare benefits need also to be considered. Two examples of successful fish farming that use very different economic systems are mullet culture on an Israeli kibbutz and milkfish culture in Indonesia. In the former, capital and profits are controlled by the entire kibbutz collective and the needs of the farmers are supplied by the collective; no salaries are paid. In the latter, the farm owner invests the capital, does not work on (or manage) the farm, but receives 2/3 of the profit, with the other 1/3 going to the resident farmers who actually manage the farm on a daily basis.

D. For both mullet and milkfish, in all the countries mentioned, there is a declining supply of fry available. Both species spawn in offshore waters and the fry subsequently enter estuaries, where they are collected and sold (directly or indirectly) to the fish farmers. The decline in fry numbers may be due to overfishing by the fry collectors and the reluctance of farmers to release marketable fish back to the environment for spawning. (This is an area where involvement of the Cooperative Agreement Fishery Management/Stock Assessment Working Group could potentially benefit the Mariculture group.) An alternate, long-term solution to the fry-availability problem is the hormone-induced spawning of these fish in captivity. Researchers have had some success in this area, but application of the technique on a routine, practical level is apparently not widespread.

E. The management of a fish farm for mullet or milkfish primarily involves stocking fish at the correct density, fertilizing at the proper rate, and avoiding problems of disease, predators, competitors and water quality. In the countries mentioned where farming has been successful, a common theme has been the development of a research and extension service available to the farmers. These are usually a part of the government, but can be established by a group of wealthy farmers, as well. Proper training of the farmers and a mechanism for updating them on new procedures and techniques is necessary to optimize productivity.

F. Some capital is necessary on a yearly basis for the purchase of fertilizer, medicine, pesticides, etc. Israeli mullet farms use both chicken manure and inorganic fertilizer, whereas Indonesian milkfish farms use only vegetable manure. A

nationwide economic survey of Philippine milkfish farms indicated that most farmers could substantially increase their output if they increased input (both fertilizer and stocked fry).

G. A problem at harvest time is that an additional pool of short-term labor is needed to assist with collection of the fish. This aspect needs to be integrated with other nearby, usually agricultural, activities. Payment of the short-term workers is usually a portion of the catch. Once the fish have been harvested, they must be marketed immediately because of their perishability. Methods of preservation for long-distance transport or storage are obviously needed. Just as the availability of fry shows seasonal peaks, so does the subsequent supply of marketable fish. It would be beneficial for the marketable fish to reach market at all times of the year, rather than during seasonal glut periods.

3-4 Brine Shrimp Culture

The need for Artemia at various life stages has been well-documented above. It represents the key food for larval forms for many species used in mariculture (see Simpson et al 1983 Zooplankton as a Food Source in 2nd Int. Conf. on Aquaculture Nutrition). In work conducted at URI it was found that some geographical locations yield Artemia which support survival and growth of cultured species, while others lead to high mortalities. The basic key is the fatty acid profile of the Artemia, which is dependent on the algae of the pond, which in turn is a result of the pond management. In a joint research project between URI and SEAFDEC, it was shown that very large amounts of the 20:5W3 fatty acid, which is critical to the quality, can be obtained by feeding Artemia on certain algae.

Some important considerations in establishing an Artemia culturing facility:

A. Location of ponds - near salt and fresh water sources, separated from farming operations, near shrimp or marine fish hatcheries. May use some ponds as salt-making facility.

B. Depth of pond at least 30 cm - or deep enough to control temperature and encourage right algal bloom.

C. Fertilization of pond with organic fertilizer.

D. Management of ponds to harvest adults and cysts as food for shrimp and other maricultural species.

E. Quality control to assess hatchability, fatty acid profile, etc.

F. Vacuum-pack dehydrated cysts for long-term storage or export.

3-5 Further Support

With the present planned shrimp production in LDC's there will be a great need for consultants and projects for shrimp and Artemia production. The demand for Artemia cysts will exceed the supply by two times. In the Artemia "poor" countries the problem is exacerbated by currency restrictions. Proposals are pending with private and public organizations, e.g., CARE, SEAFDEC, Island Resource Foundation and private sector.

4. Desirable Linkages

Linkages in Place

International Study of Artemia (ISA), Consortium of Research Groups working on Artemia - Univ. Gent, Belgium; Univ. College of Swansea, Wales, UK; CSIC, Castillon, Spain; Univ. of Milan, Italy; EPA, Narragansett, RI

Southeast Asia Fisheries Development Center, Aquaculture Department (MU)

Kasetsart Univ. Faculty of Fisheries (MU)

National Research Council, Bangkok

Island Resource Foundation, St. Thomas - Program Associate

ICLARM - Philippines

AURDC - Taiwan

Kagoshima Univ. Marine Biochemistry, Japan

Oceanic Institute, Honolulu, HI

IFS - Sweden

FAO - Rome, Bangkok

Fisheries Research Institute - Szarvas, Hungary

NFI - Washington, DC

American Society for Tasting and Materials, Philadelphia, PA (ASTM)

Aqualab, Guayaquil, Ecuador

Al Shurug Trading Est. U.A.E.

CARE

5. Expected Results

Long-term training - M.S./Ph.D. of LDC students

Short-term training

Cooperative aquaculture training program

Feasibility studies on Artemia or shrimp production/economic or social analysis

Consultants

Cooperative Agreement participation in 2nd International Conf. on Artemia, Belgium Support Students

Participate in teaching in Artemia training course. Gent, Belgium

Various private sector representatives from Ecuador, Indonesia, Dominican Republic, Haiti, and in the U.S. have approached the URI Mariculture group for various technical advice. In more than one case, these contacts have arisen from consulting work outside of the Cooperative Agreement. AID representatives in Indonesia and the Dominican Republic have suggested that our Cooperative Agreement be modified to allow us to work with designated private sector representatives.

Mariculture as an enterprise is an area which might best be addressed through the Office of Employment and Enterprise Development as well as the Office of Rural Development. The determination as to which office a potential project will be run through might best be determined by the principal investigator and AID Embassy staff after a careful review of its composition.

Initiatives should be made to develop dialogues with development banks in areas of primary interest. ICMRD associates could serve as technical advisors, evaluators as well as potential recipients for projects. The Cooperative Agreement could provide the initial catalyst for some of this activity.

POST-HARVEST FISHERY LOSSES

I. Description of Problem

Reports by various international groups and agencies (NAS, 1978) indicated that considerable post-harvest losses occur in developing countries in small-scale fisheries within the entire post-harvest system. It has been estimated that these losses range from 20 to 40 percent of the total catch. Major losses are due to improper handling, contamination, and other related factors resulting in fish spoilage.

An increase in the production and availability of high-quality fishery products, therefore, can be realized through the introduction of an appropriate and effective post-harvest fishery system to minimize losses. The small-scale fishery operation directly affects the well-being of a major portion of the poor by way of both employment opportunities and food consumption.

Considering the nutritional aspects, fish is one of the most important animal protein foods available in many less developed nations. Approximately 28 percent of the world fish supplies is consumed by the less developed countries (LDC's). In relative terms, over 60 percent of the population in these countries receive more than 30 percent of their animal protein from marine foods (Cornell, 1979). Fish, therefore, can be regarded as a main and indispensable item in the diet for many countries. Fisheries will indeed continue to make a significant impact on food supplies in developing nations.

Major Elements

It has been estimated that fish supplies 17 percent of the world's animal protein intake (NAS, 1978). Fresh fish is the principal form for human food in LDC's (FAO, 1975). FAO estimates for fisheries in some countries place fish losses among the highest for all food commodities, although no reliable data for any developing country exist. Estimates of post-harvest losses included 10 percent of fresh fish (spoilage) and 25 percent of dried fish (insect infestation).

The general causes of post-harvest fishery losses and basic characteristics can be assessed as follows:

- Serious post-harvest losses occur immediately after harvest on board due to inadequate means for proper preservation.
- Significant post-harvest losses are caused by enzymatic spoilage and insect infestation throughout the post-harvest fishery system (catch to marketing) - see attached schematic.
- Increased losses occur due to poor methods and practices for handling, preservation, transportation and marketing.

Specific problem areas are addressed as follows: (1) Spoilage, (2) Contamination, (3) Inadequate distribution and marketing methods,

and (4) Human resistance to change as related to traditional preservation and handling methods.

(1) Spoilage - primarily due to poor storage (cold) facilities, poor storage practices (unsanitary conditions), and poor preservation techniques (lack of ice).

(2) Contamination - primarily due to the lack of pest control (insects, rodents, birds), lack of standard quality control, and pollution (water quality).

(3) Distribution and marketing - primarily due to a lack of adequate transportation and infrastructure, poor packaging methods, and an unpredictable change in market demand.

(4) Human resistance to changes - primarily due to basic resistance to technological changes in traditional preservation methods, packaging techniques, product forms, and new products.

An understanding of the socio-cultural factors associated with the small-scale fisheries concept is needed to assess the impact of post-harvest technological changes on fishermen, processors, wholesalers, retailers, and consumers. The introduction of improved handling, storage, and preservation techniques; the use of more ice and refrigeration; and the involvement of fish processors in using improved preservation methods will encounter various amounts of resistance at all levels. Knowledge of socio-cultural factors relating to fish utilization and consumption will directly affect research efforts towards introducing acceptable quality control and improved handling methods. These factors must be monitored to evaluate the impact of change.

2. Problem Specifications and Targeting

The assessment of the major problems in post-harvest fishery losses addresses the broad scope of the issue. Stated factors may relate to some or all of the developing nations having a small-scale fishing industry. Both regional and country differences determine the applicability of these problems. Country-specific data is needed to evaluate post-harvest fishery losses. Specific geographical data will enable the introduction of appropriate and adaptative technology to minimize these losses.

USAID S&T/AGR, in cooperation with the Regional Bureaus, field missions, and other organizations of AID, has had a continuing interest in small-scale fisheries development in the developing world, with emphasis on improving the quality of life of the marginal and poorer segments of the society. A major concern in small-scale fishery development is the fact that significant post-harvest losses occur resulting in a dramatic decrease in the availability of an important human food supply. Minimization of these losses would significantly increase the availability of fish in the local diet and improve overall employment opportunities in the small-scale fishery industry.

Based on various conferences, workshops, and committees organized by FAO, IDRC (Canada), TPI (England), National Research Council (USA), and ICMRD, it is quite evident that the issue of post-harvest fishery losses is of major concern (References attached). In addition, the Bureau of Fisheries and Aquatic Resources (BFAR, the Philippines) have supported the issue of decreasing post-harvest losses by active participation in training programs in seafood utilization and processing.

The University of Rhode Island, and specifically, the Department of Food Science and Nutrition, in support of ICMRD's multidisciplinary marine research programs, has addressed the issue of post-harvest losses through the implementation of an integrated research program in fresh fish preservation, fish quality assessment, and the extension of fresh fish shelf life. Research areas include the enzymatic preservation of fish using enzyme pre-treatments, hypobaric storage of fresh fish (controlled/modified atmosphere - high humidity, low pressure, low temperature), and the development of simplified, colorimetric methods for the assessment of fish quality.

Research conducted under the CA should encompass the various aspects of improved fresh fish preservation. The development of simplified methods for fish quality assessment and fish deterioration by spoilage, should be addressed. The use of chemical pre-treatments to extend fresh fish shelf life should be explored. A main issue is determining where losses occur in the post-harvest fishery system.

Additionally, the development and introduction of simple, appropriate packaging systems which promote proper handling methods needs investigation. The implementation of a standard system for fish quality control would promote improved sanitation procedures during on-board handling, on-shore handling, transportation, and distribution. A pricing structure for fresh fish based on quality could be introduced based on determined baseline data of socio-cultural as well as technical factors.

3. Current Status and Prospects

Prior studies have been conducted on the fish quality of the artisan catch in Costa Rica and Guatemala by the Department of Food Science and Nutrition under ICMRD support. The scope of the investigation included both the capture site and the point of sale (market place). These studies illustrated the lack of proper handling and adequate sanitary practices for fresh and processed fish. Mishandling throughout the post-harvest system was a major cause of contamination and spoilage. High bacterial counts were found in containers, ice and table surfaces at the fish market.

The development of methods to extend the fresh fish shelf life via chemical (enzymatic) pre-treatments is increasing. This research is supported under the URI Sea Grant Research Program.

Identification of post-harvest fishery losses in specific geographical regions and countries is needed to implement an effective program to minimize these losses. The development of testing/research models

for specific tropical fish species is needed. Studies on the application of improved handling, sanitation, and packaging practices to the small-scale fishery situation in LDC's could serve as a basis for a long-term USAID/CRSP in cooperation with other fishery research groups (National Marine Fisheries Service, National Fisheries Institute, University Sea Grant Programs).

4. Desirable Linkages (networking)

Linkages are desirable with various national and international fishery research groups currently involved in applied research programs in fish preservation. Major linkages have not as yet been established in the area of post-harvest fishery losses. Institutions and groups conducting applicable research include the following:

- Escuela Superior Politecnica del Litoral (ESPOL), Guayaquil, ECUADOR
- Central Food Technological Research Institute, Mysore, INDIA
- Bureau of Fisheries and Aquatic Resources, Manila, the PHILIPPINES
- Southeast Asia Fisheries Development Center, Bangkok-THAILAND
- Tropical Product Institute, London, UNITED KINGDOM
- FAO of the United Nations, Rome
- Torry Research Station, Torry, UNITED KINGDOM
- National Fisheries Institute, Washington, USA
- National Marine Fisheries Service, NOAA-Regional Offices
- Virginia Polytechnic Institute and State University, Sea Grant Program

Linkages have been established with the Bureau of Fisheries and Aquatic Resources (BFAR), the Philippines, via a short-term training program in the Preservation and Packaging of Fishery Products -- Seafood Processing and Utilization/Seafood Packaging. This linkage can be further strengthened through implementing applied research programs in fish preservation at the small-scale fishery level.

In addition, a collaborative research and training program in post-harvest fishery losses was planned during a meeting of the working groups held at ESPOL in Guayquil, Ecuador. Post-harvest fishery losses are to be addressed under the Ecuadorean situation as it relates to losses in fresh fish quality due to spoilage, contamination, and methods of handling, transportation, and packaging. It is proposed that this program focus on determining where losses occur within the post-harvest fishery system. The extension of the shelf life of fresh fish is addressed by implementing improved methods to minimize losses. The

program design would concentrate on evaluating specific product; handling/preservation; and packaging models.

AID officials can be involved more through a strong "feedback system" which identifies countries and regions desiring research programs in minimizing post-harvest fishery losses.

5. Expected/Intended Results

- The establishment of long-term research program focusing on minimizing post-harvest fishery losses specifically for small-scale fisheries in developing countries. Goals and research priorities.

- The establishment of linkages and networks with fishery research institutes.

- The development of specific research capabilities in appropriate technology to address post-harvest fishery losses.

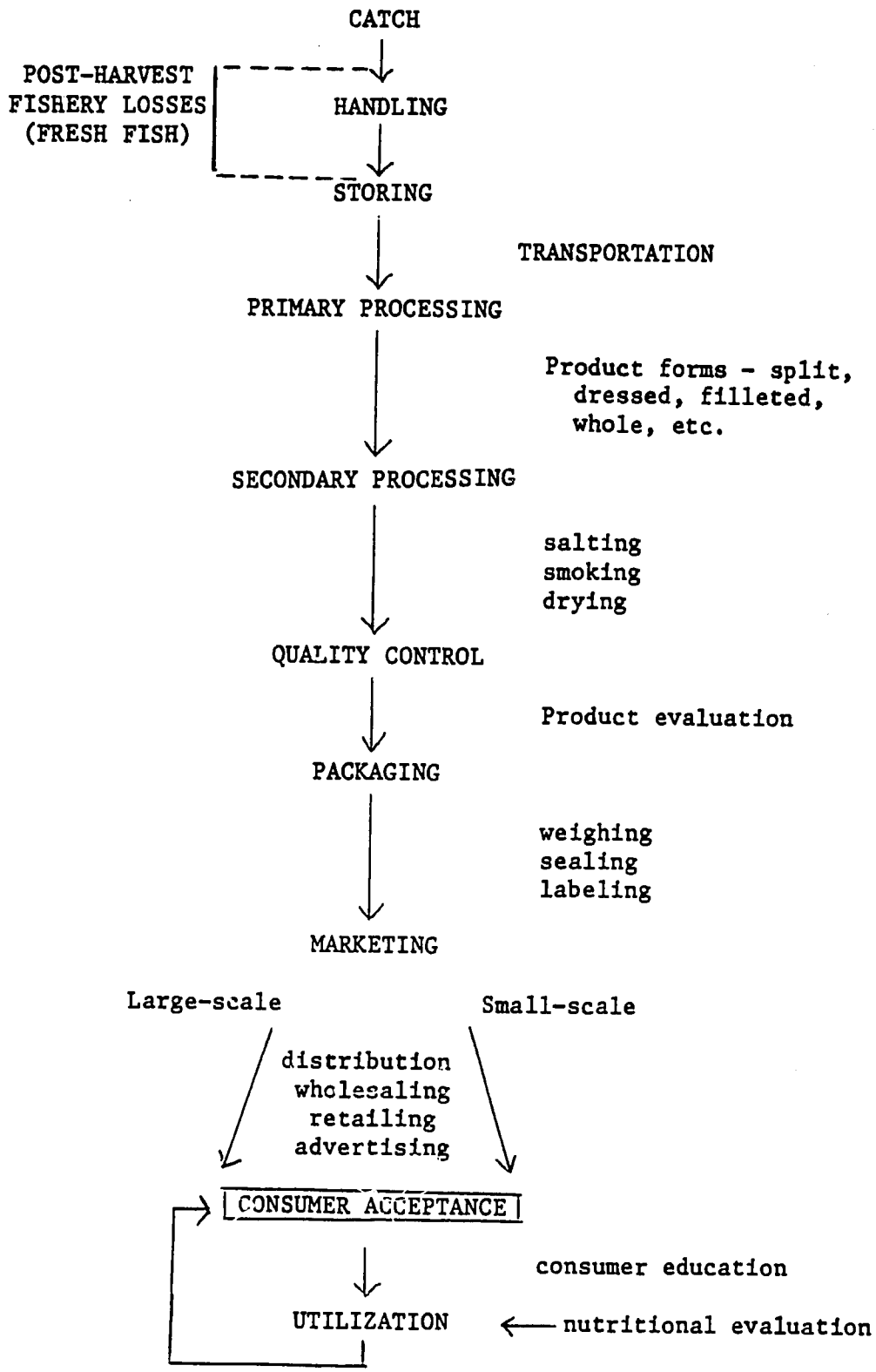
- The development of workshops and seminars on post-harvest fishery losses.

- The development of special training programs (in-country) in sanitation, quality control, and fresh fish preservation.

- The dissemination of research findings and the reporting of baseline data in guides, manuals, and working papers.

- Support for graduate research in post-harvest fishery losses.

Schematic - Post-harvest processing system for fishery products:



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