

M A R I C U L T U R E I S S U E P R O F I L E

Tanzania Mariculture Issue Profile

Prepared by
Tanzania Coastal Management Partnership Support Unit
and the
Mariculture Working Group

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PREFACE

This study identifies and characterizes the environmental management and governance issues associated with mariculture development in Tanzania.

Mariculture was chosen as a model issue for analysis of the constraints and opportunities for economic development in an integrated coastal management (ICM) context, as the issues faced in mariculture development are illustrative of generalized challenges and opportunities in ICM. Thus, lessons learned in applying the tools and concepts of ICM to guide and integrate mariculture development will pave the way for addressing other development challenges.

Mariculture development provides a good model for institutional analysis and issue identification because it typifies many of the economic activities that are increasingly exerting pressures on coastal areas. From a governance perspective, it represents a multi-disciplinary field requiring close intersectoral coordination and cross-sectoral policy development. From an environmental management perspective, mariculture exemplifies some of the more complex challenges, because it is often conducted where terrestrial and aquatic habitats meet, and is closely linked to other socioeconomic activities and issues. As with most coastal activities, the fundamental challenge lies in discovering ways to shape and guide economic development to enhance the quality of life for coastal residents, while maintaining the quality of the resource base for future generations.

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ACRONYMS

ALCOM	Aquaculture for Local Community Development Program
CBO	Community-based organization
CDC	Commonwealth Development Corporation
CITES	Convention on International Trade in Endangered Species
DSM	Dar es Salaam
EIA	environmental impact assessment
FAO	Food and Agriculture Organization of the United Nations
FDC	Fisheries Development Center
FTI	Fisheries Training Institute
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
IMS	Institute of Marine Sciences
IMPS	Integrated Mariculture Pond Systems
NEMC	National Environment Management Council
NGO	Non-government organization
RIPS	Rural Integrated Project Support
TAFIRI	Tanzania Fisheries Research Institute
TBS	Tanzania Bureau of Standards
TCMP	Tanzania Coastal Management Partnership
TCZCDP	Tanga Coastal Zone Conservation and Development Programme
TIC	Tanzania Investment Center
Tsh	Tanzania shilling
UDSM	University of Dar es Salaam
UNDP	United Nations Development Program
UNEP	United Nations Environment Programme
ZANEA	Zanzibar East African Seaweed Company
ZASCOL	Zanzibar Agro-Seaweed Company Limited

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EXECUTIVE SUMMARY

MARICULTURE ISSUE PROFILE

INTRODUCTION AND METHODS

The *Mariculture Issue Profile* report was prepared by members of the Mariculture Working Group (MWG) of the Tanzania Coastal Management Partnership (TCMP). The MWG is intersectoral and inter-disciplinary; its members are experts drawn from relevant government, and private and public institutions, including individuals having a stake in coastal and marine areas of the United Republic of Tanzania.

The purpose of the TCMP mariculture issue profiling process is to identify and characterize the environmental management and governance issues associated with mariculture development in Tanzania. This is the first step in policy development and implementation for a sectoral topic linked to integrated coastal management (ICM). Mariculture was chosen as a leading issue to test ICM approaches because it typifies the challenges presented in planning and managing coast-related economic opportunities in a sustainable manner. Lessons learned and methodologies developed through applying the tools and concepts of ICM to mariculture can be used to address other intersectoral issues along the coast.

Preparation of the report started in March 1998 when the MWG was formed by the TCMP. The report preparation process then included the following key steps:

- *Collection, review and synthesis of available information.* The working group members consulted multiple sources of information in and outside the country.
- *Working group meetings and workshops.* Through meetings, workshops and retreats, the MWG shared experiences and assessed the prevailing issues.
- *Consultations.* Interviews were conducted with relevant individuals and institutions at local, national and international levels.

- *Field observations.* Members of the working group visited all coastal districts for on-the-ground verification of the identified issues.
- *Initial findings.* The results of this work were presented at the Integrated Coastal Management Policy Meeting in October 1998.

OPPORTUNITIES AND CHALLENGES

Tanzania, with its rich natural heritage, high biodiversity and relatively unspoiled coastal environment, holds great potential for mariculture. Tanzania already has an emerging, village-based seaweed farming industry, and is just entering into other forms of mariculture. Continued growth and diversification of the mariculture industry is expected at two levels. At the village level, mariculture can alleviate poverty by providing an alternative form of crop production, and providing income and protein. At the national level, mariculture can lead economic development and generate foreign exchange.

Mariculture encompasses the cultivation of many varieties of plants and animal species in a wide range of habitats. The scale of mariculture can range from small-scale, family-run operations to large-scale, industrial projects. Experience with mariculture to date is largely limited to seaweed farming in Zanzibar. The demonstrated socioeconomic benefits of seaweed farming in coastal communities have led to its spread to Mtwara, Lindi and Tanga.

Large expanses of unspoiled coastal habitats in Tanzania offer potentially suitable sites for mariculture development, if care is taken to not reduce the ecological or economic value of critical habitats. As Tanzania confronts the growing number of opportunities and challenges presented by mariculture development, care must be taken that development proceeds in a manner that safeguards the nation's vital natural resources and maximizes social benefits. The basis of sustainable mariculture development is careful planning and intersectoral integration, to avoid potentially irreversible damage to ecologically critical areas and unintentional but costly conflicts with other economic activities such as fisheries, agriculture and forestry.

The ability to develop sustainable mariculture activities along the coast will depend on establishing necessary institutional and technical preconditions. Public sector institutions play an important role in each stage of mariculture project development. From the initial stages of project planning and approval, to the construction and operation stages, public institutions play key roles in guiding and regulating industry while promoting its growth. Thus, a strong emphasis is placed on institutional strengthening and capacity building.

ENVIRONMENTAL MANAGEMENT AND GOVERNANCE ISSUES

Through the process outlined above, the MWG identified the following priority issues:

1. Detailed mariculture guidelines that lead the appropriate institutions and other stakeholders during the approval process need to be developed.

Guidelines that direct mariculture development procedures and related environmental and financial aspects are essential to promoting development of mariculture while ensuring sustainability.

Key management tools need to be further developed as part of the guidelines and integrated into the approval process. These include environmental impact assessment (EIA) requirements, monitoring, licensing, siting criteria, zoning and environmental quality standards. Integration and use of these tools in mariculture project planning and approval should be specified in the guidelines and supported by policy.

EIAs should be a key component of the approval process. General EIA guidelines need to be reviewed and adapted for the purposes of mariculture development. It is important that they include social as well as environmental factors, recommended mitigation measures, and that they are linked to subsequent monitoring. A national monitoring framework that includes collection of baseline data, and specific procedures for operations monitoring is also needed. Environmental quality standards need to be developed and integrated into the monitoring scheme and EIA requirements.

Guidelines need to address management and oversight of mariculture facility construction and operation.

Oversight of construction and operation of projects is not included in the current regulatory system. There are no regulations covering operating procedures, monitoring requirements, environmental quality standards, best management practices, or enforcement capacity. Many potential environmental impacts related to siting and construction can be prevented by establishing siting criteria and implementing land use planning methods such as zoning. Potential impacts related to operations can be prevented or lessened by developing and using best management practices, and creating a system of monitoring and regulatory oversight.

2. Clear articulation and integration of policy and procedures is a precondition to successful mariculture planning. This includes procedures for obtaining permits, licenses, land titles, evaluation of feasibility and other approvals for projects.

Among the principle findings of the issue identification exercise carried out by the MWG is that the most critical policy and institutional issues lie in the mariculture approval process.

The project approval process provides a good example of why ICM is urgently needed to guide mariculture development. From a governance perspective, managing mariculture development requires close intersectoral coordination and cross-sectoral policy development.

There is currently no comprehensive mariculture policy statement that adequately specifies the legal and institutional frameworks governing all aspects of project approval. The approval process for mariculture projects involves many sectors and institutions, each with its own policies, procedures and regulations governing its own role and responsibilities in the process. The lack of comprehensive mariculture policy guidelines that specify coordination mechanisms for the approval process have resulted in considerable uncertainty among the responsible institutions and the public as to their respective and joint roles in the process, and how these can be most effectively coordinated.

Clear approval guidelines specifying approval procedures, and institutional roles and responsibilities will help public organizations carry out their functions more effectively.

3. Objectives and strategies to guide mariculture planning and development in Tanzania need to be carefully formulated, to recognize the different issues and opportunities associated with small, village-based and large-scale commercial operations. A national mariculture development plan that identifies goals, opportunities and challenges could be the vehicle to guide strategic planning and development initiatives, and provide a framework to better use existing capacity and resources.

The ability of individuals, companies, government and development agencies to plan for mariculture projects that are financially and environmentally sustainable is handicapped by a lack of technical capacity and scarce resources. There is relatively little mariculture experience on which to build, with the exception of seaweed farming. Although seaweed farming has produced economic and social benefits, there are limited resources for systematic technology transfer, applied research and extension that would promote replication of this successful experience. There is a need to promote mechanisms to transfer information and experience from both within and outside Tanzania to assist in more rapid development of sustainable mariculture practices.

Planning and development of projects is also complicated by a lack of financial support, as the feasibility and environmental sustainability of mariculture remains to be demonstrated to the satisfaction of private sources of capital and funding agencies. Demonstrating the economic feasibility of sustainable forms of mariculture will help encourage lenders and donors to provide credit or grants. Biological and economic feasibility can be demonstrated by identifying and testing pilot scale sustainable mariculture activities in appropriate sites. Biological, environmental, technological and economic requirements must be considered. A proactive approach to shaping the future of mariculture development can begin by developing best management practices and sustainable mariculture management.

4. Sustainable development of small-scale mariculture can be facilitated by increased coordination between national and local authorities, and increased support to local governments by central government, particularly in the areas of land acquisition and project approval processes. These actions will help ensure that mariculture activities are appropriate and sustainable.

The MWG identified a division of responsibility for mariculture development and project approval between central government institutions and those at the district and village level. One of the key steps in the current approval process is obtaining the right to use land for mariculture purposes, the responsibility for which lies mainly at the lower levels of government. However, acquisition of land is not tightly linked to, nor conditional upon, gaining approval at the national level for such key steps as assessing environmental impacts and technical feasibility, granting of business and tax licenses, and stipulating mitigation measures. Closer communication and integration of national- and district-level activities related to the approval process would help ensure that mariculture development is sustainable, and provide increased clarity on procedures and requirements.

5. A mechanism is needed whereby the various stakeholders have an opportunity to participate in mariculture project planning and decisionmaking.

The participatory nature of the district- and local-level processes should be supported and strengthened. All resources used by mariculture (land, water, access rights, biological resources, etc.) should be subject to clear and rigorously defined permitting procedures that allow evaluation by stakeholders, researchers and policy makers. Extending opportunities for public participation at the national level can be achieved by clarifying and making information easily available on the approval process. This information will help project planners move forward in the approval process in a timely and efficient manner. Increasing opportunities for stakeholder consultation and participation in granting approvals will prevent and resolve resource use conflicts.

6. Mariculture growth is constrained by inadequate infrastructure, limited marketing experience and insufficient technical capacity.

The ability to establish mariculture operations is constrained by limited infrastructure, poor communications, and lack of utilities in many locations that would otherwise be ideal mariculture sites. This is a generalized problem facing most forms of development in the nation. Choosing appropriate scales and types of mariculture technology can help avoid some of the constraints in this area. Small, village-level operations may be most appropriate in isolated and underdeveloped areas. In some cases, lack of infrastructure and supporting industry can be resolved through the coordinated efforts of the public and private sectors to support infrastructure development.

Constraints imposed by limited availability of technical capacity and other critical human resources can be partially resolved through coordination and collaboration between institutions responsible for research, development, training and extension.

Although the technical capacity for mariculture development is insufficient to meet the current demand, there are many qualified professionals now working in Tanzania. They can act as catalysts for a well-planned development initiative that is part of coastal zone management, if an intersectoral approach is adopted by the responsible institutions. These professionals include researchers, resource managers, extension agents, development workers and members of the private sector. The limited resources available for research, development and extension can be most efficiently used if coordinated to achieve goals identified under a national mariculture development plan.

CONCLUSION

Mariculture holds great promise in Tanzania as a form of economic development and poverty alleviation, but weakness in intersectoral coordination and the absence of cross-sectoral policy development hinder its development. Development can be promoted by strengthening the ability of institutions to act in a concerted fashion guided by intersectoral policy, and clear regulations and procedures, as yet to be formulated. Integration of policy, development of mariculture guidelines and a mariculture development plan are strategies that can help resolve the most fundamental issues that now constrain sustainable mariculture development.



Children gathering shellfish. Mariculture can help supplement traditional livelihoods by providing a source of dietary protein and a marketable product.

INTRODUCTION

PURPOSE

This study identifies and characterizes the environmental management and governance issues associated with mariculture development in Tanzania. Identifying critical issues of concern is the first step toward formulating and implementing policy to guide coastal development. Mariculture was chosen as a model issue for policy development because of the immediate need to address issues of concern, and because the topic offers opportunities to make rapid, positive progress.

Mariculture development provides a good model for institutional analysis and issue identification because it typifies many of the economic activities that are increasingly exerting pressures on coastal areas. From a governance perspective, it represents a multidisciplinary field requiring close intersectoral coordination and cross-sectoral policy development. From an environmental management perspective, mariculture exemplifies some of the more complex challenges because it is most often conducted where terrestrial and aquatic habitats meet, and is closely linked to other socioeconomic activities. As with most coastal activities, the fundamental challenge lies in discovering ways to shape and guide economic development to enhance the quality of life for coastal residents while maintaining the quality of the resource base for future generations.

The issue profile was approached from two perspectives. First, mariculture is viewed within the context of ICM. Effective coastal management is largely a question of capacity for governance. Thus, this work attempts to identify key issues of policy, regulation and institutional arrangements that affect mariculture development and environmental management. Secondly, the profile approaches the question of how mariculture can be developed in a sustainable fashion by examining the roles and interactions of coastal stakeholders in mariculture activities and related resource use.

Thus, the issues faced in mariculture development will be illustrative of generalized challenges and opportunities in ICM. Lessons learned in applying the tools and concepts of ICM to guide and integrate mariculture development will pave the way for addressing other development challenges.

METHODS

The TCMP working group was formed from members of government agencies, research and educational institutions and the private sector. All of the members had extensive expertise in fields related to mariculture development such as fisheries, forestry, business management and environmental management. The group also worked with experts from other fields to access other areas of expertise.

The MWG researched, compiled and reviewed primary and secondary sources of information. They also made field visits to the coastal regions and projects related to mariculture and ICM to interview stakeholders and make observations. Consultations were held with representatives of public institutions, the private sector and the TCMP Core Working Group. Writing was done in a participatory and collaborative way by the MWG. Drafts of the profile were reviewed by national and foreign reviewers, including scientists, resource managers, and legal and policy specialists.

The limitations of the data, subjectivity of the stakeholders interviewed, and the short history of mariculture in Tanzania should be acknowledged. While the study does not pretend to be a comprehensive treatment of the subject, it broadly identifies the major issues of concern, and suggests means of addressing these.

Chapter One

STATUS OF MARICULTURE IN TANZANIA

1

1.1 *WHAT IS MARICULTURE?*

Mariculture is a type of aquaculture defined as the managed cultivation of aquatic species in coastal waters (Pillay, 1990). Aquaculture broadly entails the rearing of aquatic organisms such as finfish, shellfish (crustaceans, mollusks) and seaweeds in a process in which at least one phase of growth is under the control of human beings.

Why is mariculture an issue?

The potential of small-scale mariculture is demonstrated by the success of seaweed farming which is a significant means of income generation for villagers along the coasts of Zanzibar and Tanzania. This and other forms of village-based mariculture are expected to grow. Several large-scale prawn culture projects were recently started or proposed, bringing the prospect of large-scale coastal development on the scene. Concurrently, attention was drawn to international experiences where mariculture projects resulted in environmental and socioeconomic impacts. Presented with both opportunities and challenges, it was recognized that the relatively limited experience with mariculture resulted in insufficient governance capacity to manage this complex, multifaceted field. Working toward mariculture and ICM policy development was chosen as a strategy for addressing issues of concern for mariculture and enabling sustainable coastal development.

1.2 *RATIONALE FOR MARICULTURE DEVELOPMENT*

Mariculture is a means of producing animal and plant species to meet the demands of a growing human population in several ways.

Mariculture is an alternative form of crop production providing cash income and protein sources. Mariculture development may be particularly appropriate for artisanal fishers and agriculturists as it provides a link to traditional activities.

Most rural people engage in several part-time activities to earn a living. Mariculture is already offering a profitable addition to this traditional array of part-time income-generating activities, and has potential for expansion.

Artisanal fishers face increased competition from growing industrial and artisanal fleets, while catches are decreasing. Costs of fishing equipment and supplies are rising, decreasing the profitability of artisanal fishing. Concurrently, agriculturists may be unable to expand or intensify crop production as pressures on available land increases. Mariculture activities offer a way for fishers and farmers to retain some cultural attributes of their traditional livelihoods, while working in a stable, profitable and productive industry.



Seaweed farms have been a success story for Tanzania at the community level.

Mariculture helps meet the growing demand for capture fisheries products.

The coastal population in Tanzania is growing at a rate of 2.8 to 6 percent annually. As coastal populations increase, pressures on capture fisheries increase, and fish stocks decline. Illegal fishing methods, such as dynamite fishing, only accelerate this trend. Mariculture is one way to meet the demand for fishery products, providing employment, and supplying products in high demand without increasing pressure on the fisheries. Mariculture may also offer an alternative to illegal fishing.

Mariculture provides many types of employment.

Whether conducted on a small or large scale, mariculture offers direct opportunities for employment. Indirectly, employment is created in other sectors that service the mariculture industry, such as processing, sales and shipping.

Mariculture generates foreign exchange.

Many mariculture products are in high demand on the international market. The Tanzanian economy depends to a large extent on traditional agricultural crops whose price is highly volatile and usually low on international markets. These crops easily become the victims of low prices when there is a world glut. Mariculture can play a role in diversifying the economy and produce crops whose prices tend to be stable and high.

Mariculture Already Provides Tangible Benefits to Tanzania

Although coastal aquaculture is not extensively developed in Tanzania, seaweed cultivation has already registered significant socioeconomic benefits at community levels. Mariculture workers such as Msuya (1996 a, b), Pettersson-Löfquist (1995), Mtolera et al. (1992), have studied the economic and social benefits accruing from seaweed farming while deliberating on the industry's environmental impacts. The authors have noted that the 20,000 individuals involved in seaweed farming have improved their standard of living and income levels.

Seaweed cultivation has rapidly emerged as a major cash crop in Tanga and Zanzibar (Map 1), producing enough cash to significantly improve the economic status of women and households. Mariculture proceeds are used to cover household costs, contribute to school fees, settle hospital bills, buy clothing and meet other expenses (Shechambo and Ngazy, 1995; Msuya et al., 1994; Eklund and Pettersson, 1992).

Mariculture provides high protein food sources in an efficient manner.

Most aquatic species are more efficient at converting feed to protein than other livestock. For some species, such as mollusks, feeding is not required. High-quality protein is produced in an efficient manner that is often less costly than other forms of animal protein.

Mariculture can be a sustainable means of production.

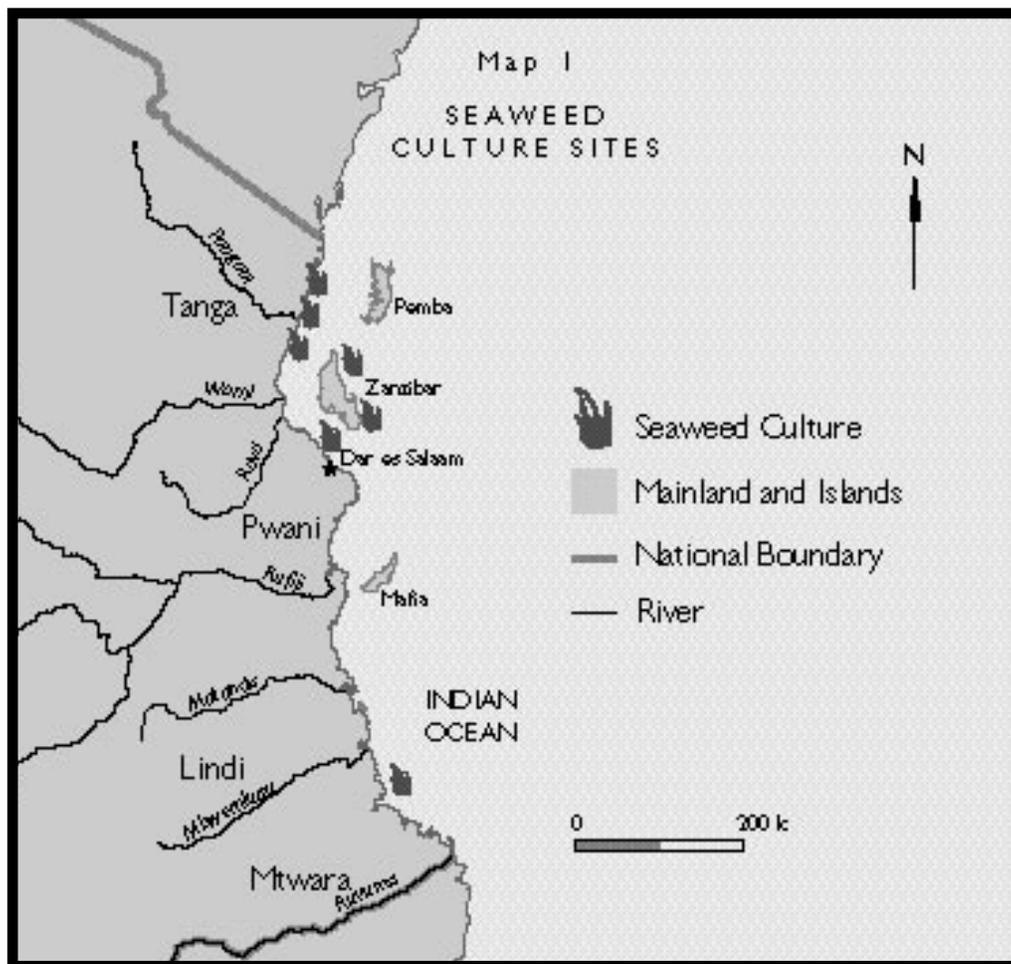
Mariculture can be an environmentally and economically sustainable means of production when properly planned and managed.

1.3 HISTORICAL ASPECTS

Only recently has a successful Tanzanian mariculture industry been established.

Fisheries development in

Tanzania began in the mid-1960s (Singh, 1976). Emphasis during the first fisheries survey, completed in 1963 (Food and Agricultural Organization/United Nations Development Program {FAO/UNDP}, 1964), was placed on efficient exploitation of the major lakes and marine waters. Attention to aquaculture (mainly small-scale tilapia culture) began during the later years of the country's Second Development Plan (1972-74). Interest in mariculture began with early investigations of seaweed farming including work by Mshigeni (1973, 1976, 1983), who introduced the concept from the Philippines. The first commercial seaweed farms in Zanzibar were started in 1989.



Seaweed farming is the only form of mariculture which can be considered an established, successful industry in Tanzania. (A chronology of mariculture experiments and attempts is presented in Table 1.1.)

Table 1.1

Chronology of Mariculture Experiments and Attempts in Tanzania

Year	Experiment	Place	Technology used
1981	Finfish <i>Siganus</i> (Bwathondi, 1981)	Unguja-Zanzibar	Cages
1983	Seaweed (Mshigeni, 1983)	Dar es Salaam	Fixed, off-bottom (pegs and ropes)
1985	Seaweed farming (Mshigeni, 1985)	Tanga, Zanzibar	Rafts and fixed, off-bottom (pegs and ropes)
1989	Seaweed	Unguja-Zanzibar	Fixed, off-bottom (pegs and ropes)
1991	Shellfish <i>Anadara</i> (Kayombo, 1991)	Mji Mwema– Dar es Salaam	Bottom culture on sandy/muddy substrate
1992	Seaweed	Pemba-Zanzibar	Floating method
1994	Finfish polyculture (Mmochi et al., 1997)	Pemba-Zanzibar	Ponds
1995	Seaweed (Msuya 1995, 1996a)	Mtwara, Lindi, Tanga	Fixed, off-bottom (pegs and ropes)
1996	Oysters (TCZCDP)	Muheza-Tanga	Tiles and rafts
1998	Finfish , shellfish and seaweed (Mmochi et al., 1997)	Unguja-Zanzibar	Integrated pond model

Slow development of mariculture has been due in part to giving higher priority to other economic activities and consequently, allocation of resources for mariculture development has been limited.

There are a number of reasons why mariculture has been developed slowly, including lack of awareness as to its potential and its low priority in the national plan. At the national level, the Division of Fisheries receives only limited funding for aquaculture development. At the regional and district levels there is no specific budget for aquaculture activities (Mafwenga, 1994).

1.4 *Potential for Sustainable Mariculture Development*

Tanzania has a rich natural heritage, high biodiversity and a relatively unspoiled environment offering the opportunity to develop a number of valuable mariculture species.

Although mariculture research and development is still on the drawing board, a number of pilot initiatives show promise. To date, the Tanzanian experience with mariculture is limited to seaweed, prawns, finfish (tilapia, rabbit fish, milk fish), and mollusks (cockles, oysters). The biological feasibility of culturing these species has been demonstrated locally and internationally. Within Africa and other regions, these and other valuable species such as pearl oysters, sponges, reef fishes and shellfish are profitably and successfully cultured. In other countries with similar climate and natural endowments, revenues from mariculture production make significant contributions to national economies. Because mariculture development has been slow, there is an opportunity to develop sustainable forms of mariculture by learning from experiences in other parts of the world.

1.5 *Mariculture Experience in Tanzania*

A review of mariculture initiatives and experiments shows that mariculture has great potential in Tanzania. Experience shows that meeting certain requirements is critical to establishing successful mariculture operations. A number of case studies are presented to illustrate key factors of success and failure in sustainable mariculture development.

1.5.1 *Seaweed*

In the 1970s and 1980s Prof. K.E. Mshigeni of the University of Dar es Salaam (UDSM) successfully demonstrated that the culture of red seaweed (*Eucheuma*) was possible. A number of coastal communities now cultivate seaweed on commercial basis (Map 1). A Kiswahili manual published by Mshigeni (1983) has proven very useful. Detailed technology appropriate for seaweed farming is also described in Mshigeni (1985), Trono (1993) and Msuya (1996a). Most villagers devote their attention to the cultivation of *Eucheuma denticulatum* (iota-carrageenan producer) and *Kappaphycus alvarezii* (kappa-carrageenan producer).

The success of seaweed farming hinges on the approach adopted during the introduction of this activity. Methods were introduced from the Philippines through an exchange of personnel. Filipino business representatives initiated a few pilot projects in Zanzibar and provided technical assistance. Methods were modified according to local circumstances as the initial pilot projects proceeded, and were well documented and disseminated.

The approach to giving technical assistance emphasized the participation and active involvement of village fishers and local fisheries officers, from the planning stage through the pilot farming stage. Farm managers were local people selected by local authorities. The companies that provided a market for the seaweed crop also contributed to this success story through financial support, provision of equipment and supplies, and technical advice.

Although initial attempts were successful and subsequently replicated, some obstacles still remain. Processing, quality control and handling capability are still below desirable levels, and marketing difficulties are foreseen. Technical assistance is needed to overcome these obstacles. To avoid overdependence on the principal species, farmers are advised to diversify their farming and pay equal attention to the cultivation of other *Eucheuma* species.

1.5.2 Rabbit fish

Cage culture of rabbit fish, *Siganus canaliculatus*, now correctly identified as *S. sutor*, was attempted at the Institute of Marine Sciences (IMS) of UDSM. A manual was also published in English and Kiswahili by Bwathondi (1981). However, the technology involved hindered the adoption of rabbit fish culture by local communities because it was expensive and difficult to adopt. Some problems identified included the fouling of nets by various marine organisms, and the high initial investment required for cage construction. Additionally, not all research findings were transferred to the community after completion, thereby preventing a second attempt using better methods. Although biologically feasible, rabbit fish are not farmed commercially in Tanzania, because the costly cage culture system cannot be adopted without extension services and financial support.

1.5.3 Tilapia

Experimental work with tilapia in freshwater ponds started in Tanzania during the early 1950s (Bailey, 1966). During that time, ponds totaling about 1,000 hectares (ha) were constructed. Lema (1988), estimated that the number of fish ponds had increased to 5000, with an average pond size of 0.1 ha. Mafwenga (1994), estimated that there were 8,611 ponds, with an average total pond area of 877.4 ha. Due to lack of proper management and use of inappropriate technology, these ponds turned out to be mostly nonproductive (Balarin, 1985; Mafwenga, 1994).

The majority of farmers culture the tilapia *Oreochromis niloticus* because of its high growth rate and suitability for pond farming. Success here can be measured by the fact that to most people, aquaculture is synonymous with tilapia culture. Tilapia are also a potential mariculture species since they can be grown in brackish and seawater.

Yields from tilapia ponds are still very low; nevertheless, the socioeconomic impact at the community level is quite significant since tilapia provide high protein food and cash income. Success with tilapia culture is due to several factors, including the requirement for a relatively low level of technology. Farm operators are willing to engage in the business because of the direct benefits rendered in the form of food and cash. Extension services are also provided.

1.5.4 Mollusks

Cockles (*Anadara antiquata*) have a high potential for mariculture development (Matthes, 1974). Experimental culture of cockles was successfully conducted in Tanzania (Kayombo, 1991) yet their culture was not adopted by the local communities due to lack of knowledge and experience.

Local communities in the Tanga Coastal Zone Conservation and Development Programme (TCZCDP) are attempting to culture oysters (*Saccostrea cucullata*). The oyster farm at Mwandusi village (situated 40 kilometers to the north of Tanga in Muheza District) is faced with a number of problems including high mortality rates (40 percent) which were probably caused by siltation, freshwater influx, predation by crabs and com-

petition for space from other organisms. Finding a market for the oysters is another challenge remaining to be solved, because potential markets are distant and transportation costs are prohibitively high. Another barrier to adoption is the long production cycle of two to three years. The economic feasibility of mollusk culture is not yet established. Wider spread culture of mollusks will remain a challenge unless suitable culture systems are demonstrated, seed availability assured and technical assistance provided.

1.5.5 Prawns/shrimp

Although very profitable internationally, prawn/shrimp culture is still largely untested in Tanzania. A number of private companies have acquired sites and permits for culture of prawns and a small farm in Bagamoyo has gone into trial production with at least one small harvest. The proposed Rufiji Delta prawn project would be one of the largest such projects in the world, if developed as planned.

Prawn farming has the potential to be a profitable activity in Tanzania, but there are widespread concerns regarding its potential environmental and socioeconomic impacts based on observation of the global industry. An additional obstacle is the lack of many of the requirements for successful prawn farming, including development policy and guidelines, technology capacity, seed sources, marketing channels and technical assistance. This form of mariculture would have to be promoted and developed with caution to avoid the environmental, economic and social problems encountered elsewhere in the world. Mistakes made elsewhere in prawn farming, such as destruction of mangroves and exclusion of traditional resource users, should be avoided.

An additional lesson learned in the case of the Rufiji Delta prawn project is that rapid and large-scale mariculture development can cause conflicts, which are harmful to the public and private sector when mariculture policy and guidelines are weak. Established guidelines, adherence to policy and regulatory requirements and careful planning are key to sustainable mariculture project development.

1.6 *Lessons Learned from the Tanzanian Experience with Mariculture*

The historic experience with mariculture is small-scale, village-based mariculture. The public institutions responsible for mariculture development have played the role of rendering technical assistance and conducting applied research on the production aspects. While these efforts were limited by scarce financial and human resources, some success was achieved. The recent appearance of several large-scale project proposals has confronted these institutions with the need to expand their role to include environmental assessment and management of mariculture. Thus, two challenges exist: to continue strengthening efforts to promote small-scale sustainable mariculture; and develop new means of managing large-scale projects, which differ substantially in their requirements.

There is now a need for comprehensive mariculture policy, regulation, development guidelines, or other environmental management tools. The capacity of government to manage mariculture development must be strengthened to allow development to proceed in a sustainable fashion. It is not only a question of preventing potential impacts of mariculture through regulations and restrictions, but also encouraging more rapid growth of sustainable forms of mariculture.

Extension and technical assistance at the local level enhances acceptance of new technology and increases the probability of adoption. Well-organized, village-level technical assistance backed by demonstration sites seems to be a catalyst in helping villagers gain confidence to solve problems and sustain interest in mariculture. A good example is the introduction of seaweed farming in Tanga, Lindi and Mtwara where a private company (International Shellcrafts) worked with extension staff to organize a program of technical assistance (Katz and Lugazo, 1996; Msuya, 1996a). In this case, villagers were trained to conduct village-level technical assistance.

Development of mariculture as an income-generating activity in coastal communities must be aimed at the needs and capabilities of villagers. These can only be known when the stakeholders are fully involved in decisionmaking during project planning and execution. The success of seaweed farming in Tanzania is due in part to multi-stakeholder

participation in its development. Appropriate technical assistance and financing was provided by government, private business, international donors and from within the communities.

There are dozens of potential species, cultivation technologies and possible sites in a variety of environments (Mgaya and Tamatamah, 1996). Promotion of sustainable mariculture requires careful planning, environmental assessment and feasibility studies. These activities should be undertaken in close consultation with stakeholders. The feasibility studies conducted by TCZCDP (Katz and Lugazo, 1996) and Rural Integrated Project Support (RIPS) (Msuya, 1996a) are good examples.



Viable markets now exist for cultivated seaweed.

Adoption of mariculture is enhanced when the benefits for engaging in mariculture are clearly demonstrated and communicated at the local level. Where other livelihood options are limited, interest in mariculture is also enhanced, as was the case in Zanzibar. If there are many options available, then the decision to promote mariculture must be weighed against the benefits offered by other alternatives. Thus, emphasis

should be placed on selecting forms of mariculture that are attractive in comparison to other options and clearly demonstrating the benefits to villagers.

Without reliable markets, mariculture will not be sustainable in the long run. Market analysis should be part of mariculture feasibility studies and facilitating access to markets should be an ongoing element of technical assistance programs. With the exception of seaweed and tilapia, which have stable international and local marketing channels, the introduction and culture of other species will depend on identifying or creating marketing channels and opportunities. The oyster culture project in Tanga still has no market outlet after three years because of the difficulty and cost of transportation.

Involvement of the private sector in providing market links, technical inputs, and training at the local level has proven critical for mariculture start-up and success. For example, the participation of International Shellcrafts in the development of seaweed culture in Tanga stimulated village-level participation (Katz and Lugazo, 1996).

In general, technical assistance and development efforts cannot focus only on the production of mariculture products; many other preconditions of successful mariculture must also be established or improved. These include transportation and communication infrastructure, rural credit facilities, processing capacity and a suitable regulatory environment.

Village-level mariculture projects can fail when the time span of technical assistance is too short and the objectives are too ambitious. An example is the FAO-funded Kenya prawn project, the largest in East Africa, which failed. Ideally, projects should start with small, pilot demonstrations and be scaled up after proving to be economically and biologically viable (Achieng, 1994).

The scale of commercial projects and the company's capability to manage the project should also be considered when evaluating project feasibility and conducting environmental impact assessment (EIA) studies. Failed commercial projects, especially large ones, can have long-lasting environmental and socioeconomic impacts.

Research and development for appropriate mariculture technology should be well planned and systematic. Where resources for research and development are limited, it is wise to prioritize species and culture systems that have demonstrated success in similar circumstances, and that are likely to be adaptable to local conditions. It is important to identify appropriate mariculture techniques that potential farmers can adopt. For example, the IMS at UDSM is developing an Integrated Mariculture Pond System (IMPS) at Makoba Bay, Zanzibar, in collaboration with Israeli researchers. The integrated system involves finfish, shellfish and seaweed. This culture technology, when successfully refined and demonstrated, can be copied by prospective farmers.

1.7 Mariculture Trends

The global mariculture industry is expanding and continued rapid growth is expected.

The worldwide demand for fisheries products is at an all-time high, while global capture fisheries are diminishing due to poor management. Mariculture products are increasingly called upon to meeting this gap between supply and demand. New culture species and new technologies for proven species make mariculture production more biologically and economically feasible. The global trend is expansion of current mariculture activities, development of new types of mariculture and intensification of culture.

Increasing interest in mariculture offers opportunities and challenges for Tanzania to take advantage of the economic growth potential of mariculture while preventing negative impacts.

As global mariculture expands and intensifies, potential environmental and socio-economic impacts become apparent. Stricter regulation, scarcity of sites, and competition with other resource users are limiting growth of mariculture in other countries. Consequently, new areas are sought for mariculture expansion. National awareness of the benefits of mariculture is increasing and a number of new projects, both large- and small-scale, are now underway (Table 1.2). As a result, the country is now presented with both opportunities and challenges. The challenge lies in developing the ability to optimize the advantages offered by mariculture development, while avoiding mistakes made in other regions and countries.

Table 1.2

Companies/Villages interested in mariculture activities

Company/Village	Site Location	Status	Species
Zanzibar East African Seaweed Company (ZANEA)	Zanzibar	Commercial	Seaweed
Zanzibar Agro-Seaweed Company Ltd. (ZASCOL)	Zanzibar	Commercial	Seaweed
Mji Mwema	Dar es Salaam	Commercial	Seaweed
C-weed Company (Kingsway International)	Zanzibar-Pemba	Commercial	Seaweed
Tanga	Tanga	Small scale	Seaweed
Mtwara	Mtwara	Small scale	Seaweed
Lindi	Lindi	Small scale	Seaweed
Mlalangaoni village	Zanzibar	Small scale	Milk fish
Nungwi	Zanzibar	Small scale	Ornamental fish
Kiuyu	Zanzibar-Pemba	Small scale	Polyculture
Mwanakwerekwe	Zanzibar-Unguja	Small scale	Aquarium fish
African Fishing Company	Rufiji Delta	Commercial	Prawns
Prawntan Company	Bagamoyo	Commercial	Prawns
Buyuni	DSM	Commercial	Prawns
Grammack Company	Bagamoyo	Commercial	Prawns
Bagamoyo Coastal Services	Bagamoyo	Commercial	Prawns

Chapter Two

OPPORTUNITIES AND CONSTRAINTS FOR MARICULTURE DEVELOPMENT

2

2.1 *Resources for Mariculture*

2.1.1 *The coastal environment*

Tanzania is fortunate to have large expanses of unspoiled coastal habitats. Many of these areas offer potentially suitable sites for mariculture development if care is taken to not reduce the ecological or economic value of critical coastal habitats.

Geographical setting

The coast of Tanzania is tropical, as Tanzania lies just south of the equator between longitude 29°21'E and 40°25'E, and latitude 1°S and 11°45'S. It falls within the Southwestern Indian Ocean Region of the FAO Fishery Regions (Area 51).

Tanzania has a long coastline of about 800 kilometers excluding bays, lagoons and estuaries. About 10 rivers drain into the Indian Ocean. The Pangani in the north, Rufiji in the middle and Ruvuma in the south are the main rivers. The smaller rivers include the Wami, Ruvu, Matandu, Mavuji, Mbwemkuru and Lukuledi (Map 2).

Physical, chemical and biological setting

The continental shelf is very narrow and ranges from two to 80 kilometers wide. Fringing coral reefs line the coast from north to south, and are absent from areas near river mouths. Three large islands (Pemba, Zanzibar, Mafia) lie less than 50 kilometers offshore and are surrounded by coral reefs.

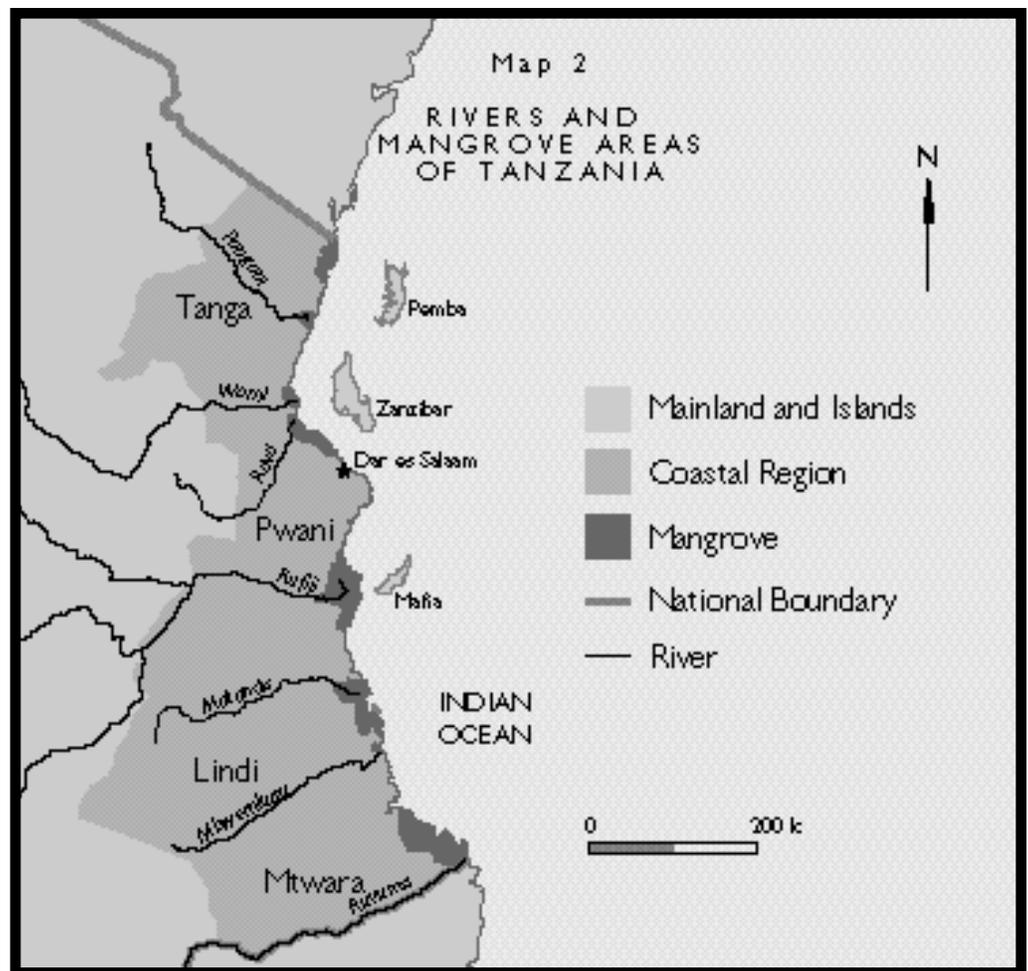
The hydrography of the shore is characterized by the East African coastal current that is a part of south equatorial current reaching the African coast at Cape Delgado. It forms

two branches: one going south to form the Agulhas Current and one going north to form the East African coastal current. This current is influenced by the monsoon wind system. During the southeast monsoon (April-October), the East African coastal current is fast, reaching about four knots. During the northeast monsoon (November-March), the speed is reduced to 0.25-2.0 knots (Newell, 1959). The tropical ocean is noted for its lack of seasonality, but Tanzania's coast has definite seasons characterized by the monsoon regime (Bryceson, 1982). The inshore waters have clear seasonal nutrient regimes. The northeast monsoon is characterized by calm water and high nutrient production due to nitrogen fixing cyanobacteria *Oscillatoria*. The southeast monsoon is characterized by rough seas, with reduced nitrogen fixing processes taking place.

Coastal waters have high primary productivity due to shallow water and nutrient runoff from the land. This decreases rapidly towards the deep ocean due to the narrow continental shelf. Rivers may

naturally carry large amounts of sediment to form deltas like the Rufiji Delta, in addition to sediments from human activities that cause erosion. Erosion and dynamite fishing in coral reef areas may also cause sedimentation in coastal areas.

The inshore waters are characterized by a wide range of tropical fish species ranging from coral reef fishes to oceanic species like tunas. Mammals, birds and turtles are present.



The various coastal habitats like the mangrove forests, seagrass beds, deltas, bays and lagoons are home to numerous species of fish, crustaceans, mollusks, birds, insects, macroalgae, phytoplankton and zooplankton.

2.1.2 Coastal habitats as potential mariculture sites

Coastal habitats are the foundation of biodiversity and support nearly all coastal economic activities including fishing, agriculture and forestry. Sustainable mariculture development requires careful integration of activities in selected sites to avoid damaging ecologically critical areas and disturbing other economic activities.

Mangrove areas

Mangrove areas were sometimes mistakenly targeted as sites for certain mariculture activities that require large-scale cutting or other severe disturbance. Loss of mangrove forests can cause severe environmental and socioeconomic impacts such as loss of valuable fisheries resources, impoverishment and dislocation of traditional users, and loss of storm and erosion protection in vulnerable areas.

These losses may far outweigh the potential benefits of mariculture planned for these areas. However, mangrove areas can host certain forms of mariculture where the trees are not cut or are selectively cut in a very limited fashion, thus allowing the mangroves to continue to play an important ecological and economic role.

Mangroves are an important and valuable resource since they support much of the coastal human population by serving as nurseries and feeding grounds for fish and crustaceans, fishing areas, sources of wood, and protection for coastal areas from erosion and storm damage (Tables 2.2, 2.3). Large segments of the population depend on mangrove areas and associated wetlands for subsistence activities and agriculture.

The largest extent of mangroves in mainland Tanzania are found in the Rufiji Delta (approximately 53,000 ha) (Map 2). Fairly large areas are also found in Tanga, Kilwa,

and in the estuaries of Ruvu, Wami, Pangani and Ruvuma rivers. According to Semesi (1991), mangrove areas occupy a total of about 115,000 ha on mainland Tanzania (Table 2.1).

Table 2.1

Specific locations of Mangrove areas in Tanzania

Administrative Block	Forest Area (ha)	Non-forested Area: Creeks, Salt Flats, Bare Saline Areas (ha)
1. Tanga and Muheza D	9,403	3,528
2. Pangani D	1,756	1,279
3. Bagamoyo D	5,636	3,548
4. Dar es Salaam R	2,168	1,045
5. Mkuranga D	3,858	2,193
6. Mafia D	3,473	892
7. Rufiji D	53,255	14,357
8. Kilwa D	22,429	14,308
9. Lindi D	4,547	2,754
10. Mtwara D	8,942	4,408
Total	115,467	50,312

Key: (D = District, R = Region) Source: Semesi (1991)

Zoning as a management strategy for mangroves

Zoning of mangrove areas is an important step towards preserving these valuable resources while allowing sustainable use. Further refinement of the zoning classification will enhance the effectiveness of this strategy and facilitate the introduction of sustainable mariculture.

Mangrove areas are classified into four categories according to their quality and allowed use (Table 2.4). Managed use and enforcement of regulations are now implemented along the coast by the Forestry and Beekeeping Division.

Table 2.2

Direct Uses of Mangrove Species in Tanzania
(Swahili names are shown in brackets)

Species	Uses
<i>Avicennia marina</i> (Mchu)	Inferior firewood, used for boiling of brine, fish smoking and production of lime; building dugout canoes and beehives; leaves used as goat and cattle fodder; branches support beehives
<i>Bruguiera gymnorrhiza</i> (Msizi or mshizi)	Good firewood, poles, fishing stakes
<i>Ceriops tagal</i> (Mkandaa)	Good firewood, poles, fishing stakes, fence posts
<i>Heritiera littoralis</i> (Msikundazi or mkungu)	Good firewood, timber for boat building, furniture, dhow masts
<i>Lumnitzera racemosa</i> (Mkandaa)	Good firewood
<i>Rhizophora mucronata</i> (Mkoko or mkaka)	Good firewood, poles, fence posts, fish traps, fishing stakes
<i>Sonneratia alba</i> (Mlilana or mpira)	Inferior firewood, commonly used in boat building, pneumatophores used as fish net floats
<i>Xylocarpus granatum</i> (Mkomafi)	Good firewood, used for fish smoking; boat building; making furniture; seeds are used to treat stomach problems; fruit pulp used to cure rashes.

Source: Semesi (1991)

Table 2.3

Ecological and Economic Importance of Mangrove Habitats

Mangrove habitats are key to the ecological and economic well-being of coastal areas because of the important functions they fulfill. Mangrove areas provide the following:

- *Nursery grounds for commercially important species such as lobster, fish and shrimp*
- *Protection of the coast from erosion caused by floods and storms*
- *Removal of organic nutrients from water*
- *Areas for fishing and shellfish gathering*
- *Sources of wood for construction and firewood*
- *Habitats for wildlife and birds*
- *Protection of coral reef and seagrass areas from sedimentation*

Mangrove areas as mariculture sites

Mangrove areas throughout the world are used for a variety of mariculture activities, with varying levels of benefits and impacts. The question of whether mariculture can be sustainably practiced in critical habitats, such as mangrove areas, and how this could be done, is complex and remains to be tested.

Table 2.4

The Four Mangrove Management Zones and their Functions and Uses

Zone	Management Strategy	Function	Use Permitted	Users/ Beneficiaries
I	Totally protected forests	Windbreaks Fish nursery Erosion protection	Research Training	Scientists/students FBD personnel Fishermen/villagers
II	Productive forests	Supply mangrove products	Poles Fuel wood Beekeeping Timber	Villagers/outsidiers Villagers Villagers/outsidiers Villagers/outsidiers
III	Forests requiring recovery	Future supply of wood products	Beekeeping Research, Training/ Demonstration	Villagers Scientists/students Personnel
V	Development areas	Aquaculture Salt production Recreation	Research Training Fishing Beekeeping Tourism Fuel wood Other local uses	Scientists/students Personnel Fishermen Villagers/outsidiers Tourists Villagers Villagers

Source: Semesi (1991).

Needs

Continued protection of mangrove habitats is crucial so that they can continue to serve their important economic and ecological roles. The zoning system in use under the mangrove management plan is a firm foundation for conservation and regulated use. The ability of the Division of Forestry and Beekeeping to actively enforce the guidelines along the entire coast is limited by the lack of resources and should be strengthened. However, some refinement of this system may be required in reference to mariculture development. The term "aquaculture" covers a wide range of types and scales of activities. Some forms of mariculture may be inappropriate even for Zone IV (development areas), while other types might cause little if any impact even if conducted in Zone I (totally protected areas).

There are many forms of mariculture which are practiced in and around mangrove areas throughout the world. Protection of mangroves has recently been the focus of the international debate surrounding environmental and socioeconomic impacts that may occur when large areas of mangroves are cut in order to construct shrimp ponds. Yet, there are other forms of mariculture that can be conducted in mangrove areas without causing such extreme impacts and shrimp culture, when sited out of mangrove areas, has a much lower level of impact.

Proper management of mangrove areas can aid mariculture efforts



Appropriate use of mangrove areas for mariculture activities includes culture of mollusks, mangrove crabs (*Scylla* sp.), and pen or cage culture of finfish. In some countries such as the Philippines, mangroves themselves are now considered as mariculture species. Previously deforested areas are being replanted and cultivated to restore habitat and provide a sustainable source of timber and firewood. These types of mariculture either improve the quality of mangrove areas or produce little, if any, impacts.

Activities that require cutting mangroves, interfere with natural flows of water, or exclude traditional resource users, are now generally considered inappropriate uses for mangrove areas. In some countries, very

limited areas of mangroves can be removed to permit canal construction for mariculture projects built further inland. In these cases, careful planning to limit the amount of mangrove removal, and mitigation by replanting mangroves in other areas is required.

Since mariculture describes a wide range of activity and practice, more detailed permitting criteria with reference to siting in mangrove areas will help promote sustainable economic development.

Under the Mangrove Management Plan, aquaculture is one of the activities allowed in Zone IV (Development Areas), but detailed criteria is not yet developed to establish precisely which types of mariculture could be conducted in this area without significant environmental impacts. Some forms of mariculture could produce impacts even if conducted in Zone IV areas. On the other hand, there may be forms of low-intensity, small-scale mariculture beneficial to local economic development that could be conducted in other zones without environmental damage (e.g. mangrove crab culture).

Coastal wetlands (non-mangrove)

Coastal wetlands merit protection because of their ecological and economic importance, yet there is no systematic classification and protection for coastal wetlands other than for mangroves. Certain forms of mariculture may be possible in wetland areas if large-scale excavations and removal of vegetation are not required. Zoning or other methods of protecting these valuable areas are still lacking in Tanzania.

There are a number of different classification schemes for wetlands, depending on the topography, vegetation and hydrological regime.

Wetlands are usually considered to be areas that are covered with water for at least part of the year. The salinity of the water may range from completely fresh to hypersaline.

A number of economic activities take place in these habitats including fishing, salt panning and rice farming. Wetlands also serve as nursery grounds for aquatic organisms, slow flooding, retain water for irrigation and provide feeding grounds for migratory birds.

Needs

As pressures on resources increase along the coast, ways to sustainably integrate economic activities and mangrove protection are needed. The ability to conduct certain mariculture activities with minimum impacts in protected areas deserves careful assessment and consideration. First, types of small-scale, low-intensity mariculture that can be sustainably integrated into mangrove areas should be identified and tested on a pilot scale. Second, the question of whether very limited areas of mangrove could be selectively removed (with mitigation) to permit the construction of water inlets and outlets for some mariculture activities should be evaluated. If allowed, systematic criteria should be established to define how and where this could be done.

Needs

Coastal wetlands are critical habitat areas currently vulnerable to degradation due to lack of zoning and management guidelines. Coastal wetlands need to be better mapped and characterized to provide an environmental baseline for habitat management and land use planning. In some cases, these areas can be appropriate mariculture sites. This requires establishing guidelines and criteria for evaluating the sustainability of mariculture operations that could be conducted in wetland areas. Then forms of mariculture that can be conducted in a sustainable manner can be identified and tested on a pilot scale.

Wetlands can also be used for mariculture activities if these activities are carefully chosen and designed to avoid negative environmental impacts. Development of management plans will aid in this. These are critical steps to devising a rational method of siting mariculture activities in these areas.

Coral reefs

Certain marine species can be cultivated in or near coral reef areas, but only under limited and strictly regulated conditions to protect sensitive areas.

Coral reefs are ecosystems of high biodiversity and economic importance. Recent studies in the coastal area of Tanzania have revealed that the reefs support extremely varied populations of fish (380 species), with large schools occurring all along the outer reef (Horrill and Ngoile, 1991).

Tanzanian reefs, however, are threatened by human activities, such as indiscriminate fishing methods, sedimentation and scuba diving (United Nations Environmental Programme, 1989; Semesi and Ngoile, 1993). Some coral reef areas in Tanzania are now under protection and are subject to restricted use, such as reefs in Mafia Island Marine Park. In the marine park system, some areas are completely excluded from use and serve as preserves, while designated multiple uses are allowed in other zones.

Mariculture could fit into the zoning scheme as an allowable use where comparatively limited operations may be carried out. For example, cultivation of giant clams (*Tridacna*), pearl oyster (*Pinctada* sp.), or corals for the aquarium trade would not adversely affect the integrity of the reef if carefully implemented. In some instances, it has been suggested that mariculture operations may act as marine reserves in cases where the operators take care to protect the environmental quality of the area (Haws, 1995; Black, 1998) knowing that this is key to maintaining production.

Intertidal areas

Intertidal areas can be ideal mariculture sites, as long as issues such as tenure, access and resource use conflicts are foreseen and addressed.

Intertidal ecosystems include sand flats and beaches, mud flats, some mangrove areas, sea grass beds, and some fringing coral reefs. Intertidal areas in Tanzania experience an extensive tidal range and provide areas that could be used for mariculture of shellfish and seaweed in particular. Common constraints encountered internationally in the use of intertidal areas are the questions of ownership, access and traditional resource use by fishers and gatherers. Ideally, mariculture activities will not affect land or marine tenure issues in these areas and will supplement, not supplant, traditional uses. Care must also be taken not to disturb certain ecosystems such as sea grass beds and fringing coral reefs.

Estuaries, lagoons and bays

Sheltered aquatic areas offer good sites for mariculture if potential conflicts with other uses, effluent control and ecosystem constraints are addressed.

Needs

Land tenure and access rights are at the center of conflicts for intertidal areas currently used as mariculture sites. Accommodation of the varying needs of different resource users of these areas is required. Given that seaweed farming and other types of mariculture will continue to expand in these areas, land use planning and zoning is also needed. This would entail mapping and characterization of intertidal areas that might serve as potential sites for mariculture activities. There is also a need to identify and test, on a pilot scale, sustainable mariculture activities in the various types of intertidal areas.

Needs

Coral reef areas and adjacent waters could provide appropriate mariculture sites if forms of mariculture with minimum impacts are chosen. Guidelines and criteria to evaluate allowable mariculture types are needed. Mapping and characterization of coral reef areas are needed before areas suited to sustainable mariculture are identified. Careful testing on a pilot scale of proposed mariculture activities could then follow.

An estuary is a body of water where a river mouth widens into a marine ecosystem. Estuarine salinity alternates between saltwater and freshwater; tidal action is an important biophysical regulator. In Tanzania, major rivers that form estuaries

include: the Rufiji, Ruvuma, Pangani and Wami. A bay is a broad inlet of the sea where land curves inwards. Lagoon refers to a body of water at least partially isolated from the sea by low sandbanks or a coral reef. Bays and lagoons are present along the mainland and island coasts.

Sheltered areas are commonly used for pen, cage, bottom, raft and long-line culture for a variety of species. These physical structures may come into conflict with other forms of

resource use such as fishing, tourism and navigation. Conversely, mariculture operations can be affected by the human population in these areas through theft, vandalism or pollution.

Needs

Areas that might serve as mariculture sites in lagoons, estuaries and bays need to be mapped and characterized. Permitted areas can then be designated as a means of avoiding user conflicts and to set upper limits on mariculture expansion. There is also a need to identify and test, on a pilot scale, sustainable mariculture activities in these sites.

Siting considerations and habitat protection

2.1.3 Criteria for site selection

The history of mariculture demonstrates that good site selection is the most important factor in determining the feasibility and sustainability of operations. There is insufficient baseline information to develop clear and comprehensive criteria for selection of appropriate mariculture sites in Tanzania. The application and permitting processes for siting mariculture projects are also complex and partially ineffective (see section 3.1.3). This hinders the ability to plan mariculture development in an integrated fashion. Lack of clear siting criteria may also result in the rejection of beneficial projects, while projects with potential impacts are permitted.

Criteria for site selection are most commonly based on the biological requirements of the species to be cultured and the technology to be employed. Under certain circumstances, criteria based on other priorities may need to be established. To protect environmentally sensitive areas, and avoid resource user conflicts or other impacts, target mariculture species may need to be selected on the basis of suitability for sites preselected for mariculture. Criteria for site selection must also consider a wide range of other factors including engineering aspects, proximity to infrastructure such as roads and processing plants, and topographic factors; discussion of which is beyond the range of this document.

Clear criteria for culture of different species and different levels of technology do not currently exist in Tanzania, but these are a prerequisite for development of sustainable mariculture, since up to 90 percent of the impacts associated with mariculture can be avoided by proper siting (Clay, 1997). The ability to make mariculture operations profitable is also dependent on securing an appropriate site.

An integrated coastal zone management approach can be helpful, as it provides tools and procedures for the integration of mariculture in ways that are sensitive to habitat protection and other resource uses.

2.1.4 Biological resources

Tanzania has a wide variety of potential mariculture species, but when targeting species for research and development efforts, consideration should be given to species with proven biological, economic and technological feasibility.

Table 2.5 lists a number of species that were cultured with success in Tanzania or similar environments, or are thought to have potential as good culture species. These species are in different stages of development and testing, while the potential of others remains to be tested.

2.1.5 Species selection

Development of sustainable mariculture depends on selecting and giving priority to species that are known to be biologically, economically and technologically feasible.

One common mistake in mariculture development is to implement projects promoting mariculture without a thorough planning process that includes assessing of which species are most appropriate in given circumstances. It is risky and expensive to promote forms of mariculture where the requisite biology and technology is not well known, since few stakeholders have the time, interest or financial resources to develop competency in these areas. Transferring and adapting technology from forms of mariculture already proven to be successful is simpler and less costly.

Needs

A comprehensive analysis of site selection criteria taking into account species requirements, levels of technology, operation procedures and environmental parameters should be conducted to match species with available and suitable sites.

Table 2.5

List of suitable species for culture

	Scientific Name	Common Name	Local Name	Priority	
				Small scale	Commercial
Finfishes	<i>Arius</i> sp.	African sea catfishes	Hongwe	+	+
	<i>Chanos Chanos</i>	Milk fish	Mwatiko	++	++
	<i>Elops machnata</i>	Ten-pounder	Hanisi/Hanithi/Kihanisi	+	+
	<i>Megalops cyprinoidea</i>	Indo-Pacific tarpon	Cheche	+	+
	<i>Mugil cephalus</i>	Flathead grey mullet	Mkizi	++	+
	<i>Oreochromis mossambicus</i>	Mozambique tilapia	Perege		
	<i>Siganus</i> sp.	Rabbit fish	Tasi	+	+
	<i>Trachynotus</i> sp.	African pompano	Kolekole	+	++
Shrimp	<i>Macrobrachium rosenbergii</i>	Giant river prawn	Kamba madole	+	+
	<i>Metapenaeus monoceros</i>	Speckled shrimp	Kamba, palu palu, kamba miti	+	+
	<i>Penaeus indicus</i>	Indian white prawn	Kamba	+	++
	<i>Penaeus monodon</i>	Giant tiger prawn	Kamba, miti, kaji	+	++
	<i>Penaeus semisulcatus</i>	Green tiger prawn	Kamba, miti, kaji	+	++
Lobsters	<i>Panulirus ornatus</i>	Ornate spiny lobster	Kamba koche	+	+
	<i>Panulirus versicolor</i>	Painted spiny lobster	Kamba koche	+	+
	<i>Panulirus longipes</i>	Long-legged spiny lobster	Kamba koche	+	+
Crabs	<i>Scylla serrata</i>	Mangrove crab	Kaa	+	+
Bivalves	<i>Anadara antiquata</i>	Cockle	Chaza	+	+
	<i>Donax</i> sp.	Wedge shells	Chaza	+	+
	<i>Modiolus</i> sp.	Mussels	Panga	+	+
	<i>Mytilus</i> sp.	Mussels	Panga	+	+
	<i>Ostrea amasa</i>	Oyster	Chaza	+	+
	<i>Perna</i> sp.	Mussels	Panga	+	+
	<i>Septifer</i> sp.	Mussels	Panga	+	+
	<i>Pinctada</i> sp.	Pearl oyster	Chaza	+	+
	<i>Saccostrea cucullata</i>	Hooded oyster	Chaza	+	+
Gastropods	<i>Cypraea tigris</i>	Tiger cowrie	Kombe	+	+
	<i>Cypraecassis rufa</i>	Bullmouth helmet	Kombe	+	+
Holothuroidea	<i>Holothuria scabra</i>	Sea cucumber	Jongoo bahari	+	+
Seaweeds	<i>Eucheuma denticulatum</i>	Red seaweed	Mwani mwekundu	++	++
	<i>Gracilaria</i> sp.	Red seaweed	Mwani mwekundu	+	+
	<i>Hypnea</i> sp.	Red seaweed	Mwani mwekundu	+	+
	<i>Kappaphycus alvarezii</i>	Red seaweed	Mwani mwekundu	++	++
	<i>Sargassum</i> sp.	Brown seaweed	Mwani kahawia	+	+
	<i>Turbinaria</i> sp.	Brown seaweed	Mwani kahawia	+	+

Source: Modified from Ibrahim (1976).

Key: ++ = High potential + = Low potential

Note: The priority rating was revised based on a review of the TCMP Mariculture Working Group of recent mariculture experiences and the scientific literature by the TCMP MWG, and takes into consideration the biological, economic, technological and social feasibility of each species.

When selecting species for mariculture projects, following certain criteria will improve the chance of success:

- Carefully defined objectives for species selection (e.g., increasing protein supplies to the poor, export for foreign exchange, or water recycling in a polyculture system)
- Reliable provision of seed within the technological grasp of users, whether through sustainable wild capture or hatchery production
- Exhibition of fast growth and ability to attain table or market size in minimum time
- Ability of species to derive its nutritional requirements from materials available from the pond and/or inexpensive artificial feeds
- Flavor, taste and texture that is acceptable to the potential consumers
- Existence of a known market capable of absorbing the planned level of production
- Ease of handling and harvest
- Previously tested production systems
- Preference for native species to avoid environmental risks posed by introducing exotic species

2.1.6 Human resources

Human capacity will determine the ability to transfer and adopt new technologies required to establish thriving mariculture operations. The capacity of the professionals responsible for technology transfer, and the farmers who will adopt and practice mariculture methods, needs strengthening.

Although human capacity is insufficient to meet current demand, a well-qualified body of professionals is now working in Tanzania. They can act as catalysts for a well-planned mariculture development initiative that is part of coastal zone management, if brought together in an intersectoral approach. These professionals include researchers, resource managers, extension agents, development workers and members of the private sector.

Needs

The feasibility of the many potential mariculture species should be evaluated. The analysis should include study of experiences and technologies from abroad and nationally. Biological, environmental, technological, and economic aspects and requirements should be considered. This analysis can serve as a basis for prioritizing research and extension efforts.

The knowledge and capacity of the general public to adopt and practice mariculture is low. Most stakeholders will require long-term, high-quality extension assistance to be able to become self-sufficient mariculturists.

The coastal population, now estimated at 7.5 million, is rapidly growing. New livelihoods are needed to maintain and improve the quality of life on the coast without additional pressures to existing resource uses. Mariculture can be integrated into the traditional subsistence patterns of resource use where people engage in numerous activities that include agriculture, fishing and forestry. Establishment of well-planned and regulated commercial mariculture ventures can offer employment. However, institutional capability for planning, regulation, technology transfer, awareness development and dissemination is minimal and requires strengthening if mariculture is to become a feasible alternative livelihood.

The institutional capacity for mariculture is low and continues to dwindle from lack of financial support and other inputs.

The capacity for integrated research and development is deficient at all levels. There are few trained aquaculturists. Most are employed by UDSM, Kunduchi Fisheries Institute, Mbegani Fisheries Development Center, Nyegezi Freshwater Fisheries Institute and Tanzania Fisheries Research Institute (TAFIRI) (Table 3.2).

With the exception of UDSM, the other remaining national training institutions cater to mid-cadre fisheries extension staff with dual roles in aquaculture and fisheries management. However, the level of technology and experience gained in the National Fisheries Training Institutions is low and mostly confined to small-scale fish farming, the bulk of which is tilapia culture. Student enrollment has decreased year after year, due to lack of operating funds. Therefore, local expertise for intensive operations and culture of other marine commercial species is seriously lacking and this situation is expected to become worse unless the trend is reversed.

It is clear that there is a need to consolidate and improve national fisheries institutions training capacity in mariculture technology. More funding for research and development and for training institutions will be key to strengthening capacity.

2.2 Environmental Aspects

Proper planning of mariculture projects is important to maximise profits while minimising the impacts to the environment. Poorly planned and managed mariculture operations may have hazardous upstream and downstream effects on the environment and coastal people, whereas properly planned operations are beneficial to the people and may have little impact on the environment.

Needs

Increasing the number and capacity of trained personnel working in mariculture and associated sectors would help spur mariculture development. This can be done by providing of training and employment opportunities for trained personnel. Increased levels of financial support for training, applied research and education would make this possible. More precise targeting of capacity building efforts can be accomplished by conducting a needs assessment for researchers and extension workers.

The severity of potential impacts can be greatly reduced or eliminated through careful planning and use of appropriate methods, monitoring and regulations. Mariculture impacts are site-specific, and their severity varies greatly depending on the level of intensity, type of technology, the species cultured and operational management. Poorly conceived and planned projects sited in sensitive areas generate public debates, risk failure and give mariculture a bad image. Mariculture projects that are well designed, suitably sited and operated using environmentally sensitive methods can have minimal impacts compared to other productive enterprises such as agriculture.

Among the most severe environmental impacts associated with mariculture are the large-scale degradation of valuable coastal wetlands (especially mangroves), land subsidence, acidification, salinization of groundwater and agricultural land, and subsequent loss of goods and services generated by the natural resource systems (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection/GESAMP, 1991). It is important to recognize that these impacts can all be avoided.

Mariculture development often entails conversion of communally owned and controlled land to private ownership, which has implications for environmental management.

Based on the theory of the “tragedy of the commons,” it is often assumed that private ownership will promote better management of a given property since the owner has a long-term stake in maintaining the quality of the resource. This presumes that the private owner(s) is motivated to do this and has adequate environmental management capacity. This has not always proven to be the case, therefore guidelines, regulation, enforcement and technical assistance are needed to improve management capacity of mariculture operators.

Appropriate systems and models should be developed in suitable areas to reduce impacts.

Existing mariculture operations in Tanzania are currently community-based, with minimum production and minimal impacts. With the advent of large-scale projects it is becoming apparent that appropriate model systems that emphasize maximising benefits and minimising impacts are needed. One of the few existing models for mariculture with minimum impacts is seaweed farming on Zanzibar and mainland Tanzania. There is also an increasing trend towards adoption of model systems. For example, an integrated model of finfish, shellfish and seaweed culture being developed by IMS at the Makoba Bay in Zanzibar, aims to reduce the impacts of pond effluents to the marine environment. Potential farmers are waiting to adopt the model if it proves successful.

2.3 Socioeconomic Implications of Mariculture

2.3.1 Demography

High migration and population growth rates result in increasing pressure on coastal resources. Alternative livelihoods and improved resource management are needed to preserve the quality of life and the environment.

Needs

Means of evaluating the potential environmental impacts of proposed mariculture projects should be developed using the existing EIA guidelines as a framework. Use of these criteria should be incorporated into the planning and approval process for mariculture.

An important part of preventing forms of development that heavily impact the environment is to identify model systems of mariculture which offer the lowest risk of environmental impacts and prioritise their implementation.

When land belonging to or used by the public is privatised, the potential for environmental degradation and socioeconomic impacts needs to be assessed, and ways to strictly enforce environmental guidelines and regulations on privately held lands must be found. Public participation in the EIA process and consideration of socioeconomic impacts can help prevent some of the major consequences of privatising land.

Mariculture guidelines, best management practices and sustainable mariculture models should be developed and tested for Tanzanian conditions to proactively shape the future of mariculture development.

In 1988, the Tanzania mainland had a population of 22.5 million (Zanzibar: 640 thousand) increasing at a fairly high average annual rate of 2.8 percent (Zanzibar, three percent). The population density in the coastal zone of Tanzania is categorized as being of medium level of between 30 to 70 persons per square kilometer, but studies of population movement and changes in population densities reveal a large flow of population towards the coast over recent years (Professor S. Maghimbi, pers. comm.). About five million people lived in the coastal areas in 1996, and the yearly growth rate was around two to six percent (Linden and Lundin, 1996). The largest concentrations were in coastal urban areas, including Dar es Salaam, Tanga and Mtwara.

2.3.2 Interactions with coastal resource users and other sectors

Most coastal residents earn their livelihood by engaging in a number of subsistence activities. Small-scale mariculture can be one element in this array of activities. Stakeholders possess skills learned in their other activities that can be used in mariculture.

Technical capacity, experience and trained personnel for mariculture development may be found in other productive sectors. Ways to build on the capacity and experience of other sectors should be considered when planning mariculture development.

As described below, mariculture is intimately linked to other productive sectors, and for this reason, its development must be approached from a multisectoral perspective.

In the coastal areas of Tanzania, people are engaged in a number of economic activities. Most of these are subsistence-level activities such as fishing and agriculture. Relatively



few people depend on large-scale industry or other commercial activities such as tourism, although this is expected to increase. Most of the economic activities mentioned here have received priority in national planning and development, and have a rich history of experiences that can be useful in the development of mariculture. Mariculture development should attempt to learn from and integrate with other sectors, in order to be more efficient.

Most rural residents make their living through participation in a variety of occupations, including fishing and agriculture.

Agriculture

Commonly grown agricultural crops are cotton, sisal, coconuts, rice, cassava, legumes, sorghum, cashew nuts, sweet potatoes, millet, bananas, fruits and vegetables. With the exception of cotton, sisal, cashews and coconuts, all crops are grown for subsistence.

Mariculture is in many ways similar to agriculture. These similarities may increase the probability of adoption if groups who engage in agriculture are targeted for technical assistance in mariculture. The agricultural sector has a long history of extension experience and has the strongest capacity in this area. Women also play an important role in agriculture production, processing and distribution; their skills are transferable to various forms of mariculture.

Livestock

Livestock keeping in Mtwara, Lindi, Coast and Dar es Salaam is very low compared to other regions like Tanga and the rest of the country. Livestock keeping is predominately traditional and is composed mostly of indigenous stock. It is limited in some areas due to tsetse fly problems.

Mariculture requires skills that are possessed by people who practice animal husbandry. In some cases, aquaculture and animal husbandry can be integrated. Technical capacity for certain aspects of mariculture also exists in this sector, such as technical assistance for animal health, reproduction and food processing.

Forestry

Coastal residents use forests for a variety of socioeconomic activities. Most important are the exploitation of timber for carpentry and carvings. The southern coastal communities in Tanzania are famous for carving and other woodwork. Most timber is sold in Dar es Salaam to supply increasing construction activities. Other trees are felled for making charcoal and firewood. It should be noted that most coastal residents in Tanzania, in both urban and rural areas, rely on trees in the form of charcoal and firewood for their energy needs. Many other trees, especially mangroves, are cut down to provide poles for building houses, since most coastal homes, particularly in rural areas, are built of mud and poles from trees.

The forestry sector will be strongly linked to mariculture since its resource users and technical personnel will strongly influence coastal planning and resource use protection. It should also be noted that mangrove reforestation itself is a form of mariculture, and that culture of some species can be integrated in a sustainable fashion in mangrove areas.

Fishing

Fishing is a major livelihood for the people along the Indian Ocean, providing food, employment and income. Both marine and freshwater fishing are practiced. Marine fishing is carried out along the entire coast by both commercial and artisanal fishers. Inshore pelagics such as herrings, sardines, kingfish, mackerel and anchovies are often caught by artisanal fishing using gillnets, hooks, longlines, traps and seine nets. There are three main types of vessels: *Ngalawa* (outrigger canoes), *Hori* and *Mitumbwi* (dugout canoes) and *Mashua* (small sailboats, or dhows). In general, fish catches are low due to poor fishing gear and boats. Commercial fishing practices are largely carried out using

longliners, purse seiners and trawlers. The most important variety of fish often caught by commercial fishermen in the offshore waters are pelagics, such as tuna and swordfish.

Freshwater fishing outputs exceed those of marine fishing, but catches are declining in both. Freshwater catches have

declined in recent years (Table 2.8) after a peak production of 347,000 tonnes in 1988 with the largest number of fishers (62,800) occurring in 1989. Marine fisheries appear to be tracking a similar decline (Table 2.8) after a peak production of 50,200 tonnes in 1989 and a high of 15,500 fishers. (Data cited for 1988 and 1989 are from Bagachwa, et al, 1994, but may be inconsistent.) This may be due to overexploitation of stocks and illegal fishing. Considering that fish may provide up to 100 percent of the animal protein consumption in coastal areas (Bagachwa et al., 1994), these declines herald an increasing demand for fisheries products and a need to find replacements.

Table 2.8

Marine and Freshwater Fisheries Resources

	1992	1993	1994	1995
<i>Freshwater</i>				
Fishers	46,470	46,916	46,639	61,694
Vessels	16,441	17,744	16,129	18,696
Metric tonnes (1,000)	291.6	294.8	228.0	197.6
Value (million Tsh.)	19,947	31,239	30,949	44,730
<i>Marine Waters</i>				
Fishers	15,027	15,027	15,027	13,822
Vessels	3,514	3,232	3,232	3,768
Metric tonnes (1,000)	43.9	36.7	40.8	48.8
Value (million Tsh.)	6,167	10,207	14,228	24,662

Source: Annual Statistics of the Fisheries Division, Ministry of Natural Resources and Tourism.

The fishing sector is closely linked to mariculture, based on the supposition that some fishers will take up mariculture because their skills and existing equipment predisposes them to do so. The fishing industry also offers experience and capacity in harvesting, equipment manufacture and supply, processing, shipping and distribution that can benefit mariculture development. Additionally, technical personnel in this sector already work in mariculture development and, under the current institutional arrangement, are responsible for progress in this area.

Seaweed farming

Seaweed farming is becoming an important economic activity in the coastal areas of the United Republic of Tanzania. Since its start in 1989 on the Zanzibar Islands, it has expanded quickly to employ more people and cover a larger area of farms. In 1992, seaweed farming expanded to Pemba and Mafia Islands, and in 1995, to the mainland (Map 1, Chapter 1). The industry has developed as a viable alternative economic activity and improved the living standards of coastal people. The number of people involved in the industry has increased over the years (Table 2.9).

The success of seaweed farming illustrates how properly conceived and planned mariculture activities can have a significant positive impact on local communities and will serve as a model for future mariculture development (see Chapter 1). Seaweed farmers, having mastered one form of mariculture, may also expand into other mariculture activities.

Table 2.9
Expansion of Seaweed Farming in Tanzania and Zanzibar from 1989 to 1996

Year	Numbers of Farmers	Numbers of Villages	Acreage (ha)	Seaweed Product (tonnes dry weight)
1989	1,000	No data	No data	No data
1990	2,000	No data	No data	808
1991	10,000	No data	No data	2,492
1992	15,000	18	420	2,487
1993	17,000*	18	510	1,768
1994	18,000*	23	530	4,512+
1995	20,060*	28*	550*	6,452*
1996*	20,645*	46+*	570*	No data

Source: Mshigeni (1992); Msuya (1992, 1996b); Annual Reports, Fisheries Department, Zanzibar.

*Estimated values

Tourism

The coastal zone is conducive to tourism, as it possesses attractive tourist sites. These include historic places such as slave trade centers and markets, bases of famous explorers, colonial buildings, and forts and ruins found in Bagamoyo, Kilwa and Zanzibar. Other attractive destinations are unique geological sites like Amboni caves, archaeological sites such as Ras Kisimani on Mafia Island, and freshwater springs on intertidal flats and bird colonies on Latham Island. There are also scenic spots including pristine coral reefs, white sand beaches and crystal-clear swimming waters. Big game reserves include Selous in Lindi region and Saadani in Bagamoyo.

Coast areas are beginning to be developed for the tourism industry. Small offshore islands were developed into tourist destinations, new beach hotels were built, and sites were allocated on beach plots along the coast.

Tourism, which attracts 400,000 foreigners annually, is a potential market for high-priced mariculture products which otherwise might not be marketable internally. Some mariculture projects are also interesting tourist attractions. However, tourism development may compete with mariculture operations for potential sites. It may also create negative environmental impacts such as pollution or increased boating activity that can pose problems for mariculture.

Industry

Nearly 75 percent of national industries are concentrated in coastal areas, specifically Dar es Salaam and Tanga. Much of the limited industry that exists in outlying areas is failing for lack of transportation, capital and other difficulties.

For mariculture development to be successful, attention must be paid to developing the associated industrial components simultaneously. These include facilities for producing equipment and supplies, processing and transportation. Training workers in these areas will also be a key factor for all forms of economic development.

2.3.3 Resource user interactions and potential socioeconomic impacts

Competition between resource users is expected to increase as the coastal population increases, land use intensifies and outside investor interest grows. Traditional methods of managing resource use and the current legal system may prove inadequate to meet present and future challenges in this area. Use of management methods under an integrated coastal zone management scheme can help promote equitable and sustainable economic development by harmonising development activities.

Mariculture requires resources such as land, water, animals and plants, and this may cause conflicts with other users. Currently there are conflicts between seaweed farming,

Needs

The current economic activities and skills of coastal inhabitants should be considered when planning mariculture development, so that types of mariculture that can be easily integrated into their lives are given priority. Forms of mariculture that require very high levels of technical training or industrial support are unlikely to succeed in the current development environment.

Mariculture is a multidisciplinary field requiring technical inputs from professionals in a number of sectors, such as fisheries, agriculture and business development. The capacity and mandate for intersectoral planning of economic development activities needs to be strengthened to avoid conflicts between resource users, maximize efficient use of land while avoiding impacts, promote equitability in who benefits from development and allow integrated multiple uses of coastal lands.

Adoption and implementation of management tools such as land use planning and zoning will increase the benefits from development and alleviate possible conflicts over resources. Water, land and access rights are important economic assets. Competition for use of natural resources and access rights by participants in different economic activities must be considered.

tourism development, artisanal fisheries, conservation and terrestrial (agricultural) activities. It is expected that the trend of resource use conflicts will increase, and that without immediate management intervention, may result in environmental and social impacts.

Resource use conflicts may have an extensive geographic distribution, since activities in distant areas can affect users far downstream.

For example, removal of mangroves on the mainland to build shrimp ponds could cause erosion and sedimentation that could affect seaweed farmers or fishers on the islands. Thus, an ICM approach is required to prevent and resolve potential conflicts.

Examples of current and potential resource user conflicts with relevance to mariculture development

Mangroves and coastal forests are increasingly becoming targets for economic activities.

Mangrove cutting can have serious environmental consequences.

The mangrove and coastal forests are being used as sources of poles, timber, firewood and salt production. Some salt production occurs in areas where mangroves were



cleared. Solar evaporation and boiling using mangroves as firewood are the principal methods. There are about 3,100 ha occupied by solar pan ponds (Semesi, 1991). Some mangroves have been cleared for other reasons.

Mangrove clearing is expected to accelerate. During a field visit to Rufiji, the Mangrove Management Project office reported that there is an extensive export of mangrove

poles to the Middle East through Zanzibar. There is no information on the extent of mangrove cleared, but physical observations on various areas along the coast show that mangroves are exploited in an unsustainable manner. Increased interest in shrimp culture and other forms of mariculture may also endanger mangroves if protective measures are not developed and enforced.

Use of mangroves for new economic activities or cutting of mangroves causes socio-economic impacts because: 1) areas which were previously open to common use are converted to privately held and controlled areas, depriving local people of their resource base; and 2) environmental impacts from mangrove removal adversely affect economic resources such as fisheries.

Privatization of communally held resources for mariculture can cause conflicts.

Mariculture activities normally require some acknowledged rights to use land, water and biological resources, and may affect access. Unplanned or ad hoc granting of rights may cause conflicts with other economic activities. For example, conflicts have arisen between fishers and seaweed farmers over rights to shore access. This is beginning to be an issue with tourism development.

Degradation of environmental quality by one economic activity affects others.

Agriculture is predominantly conducted by small holders practicing shifting cultivation that entails clearing of forests. This mode of production coupled with the increasing use of firewood has accelerated the rate of deforestation, estimated to be 39 million cubic meters per year (Berry, 1981, cited in Linden and Lundin, 1996). High rates of deforestation result in erosion and sedimentation that may affect coastal habitats which could be used in mariculture. Agriculture may also employ pesticides and herbicides such as DDT, aldrin, endrin and HCB (Hertzman and Akerblom, 1993, cited in Linden and Lundin, 1996), the use of which is increasing in Tanzania (UNEP/IMS/FAO/Sida, 1998). Deterioration of water quality from such substances will affect mariculture production.

Coastal tourism is becoming an important foreign exchange earner, with new beach hotels built and allocation of new sites increasing in Dar es Salaam, Mafia Island, Bagamoyo and in the Zanzibar Islands. However, the siting of projects along the shoreline poses a potential environmental threat to the marine ecosystem. Valuable tourist attractions such as coral reefs and beaches are vulnerable to degradation.

Inequitable distribution of benefits from development activities can cause social conflicts.

The issue of inequitable benefits usually has an impact in two ways: 1) when communally used and controlled resources are privatized, some traditional users may be deprived of their means of livelihood and suffer a loss of quality of life; and 2) when economic

development results in some individuals or families increasing their standard of living over that of the community norm, which causes friction among community members.

Examples of the first case are documented in areas of the world where shrimp farming has rapidly developed and expanded, such as Ecuador. Although some resource users are fortunate or adaptable enough to take advantage of new opportunities presented by the shrimp industry, this is not always the case. Fears that this may also occur in Tanzania may be one of the underlying sources of the current debate surrounding the Rufiji Delta prawn project.

Needs

When land that is communally owned, used or controlled is privatized, the economic and social effects on the community should be considered. The decisionmaking process for land allocation and project approval should be participatory and transparent. A forum must exist to allow for public comment and discussion before projects are approved, with a mechanism to include public opinion in the decisionmaking processes at local and national levels. Provisions under law should exist to provide for just compensation to resource users whose economic status suffers when they are excluded from using resources that were traditionally accessible to the public.

An example of the second case was encountered in the case of seaweed farming in Tanzania (Msuya et al., 1994; Msuya, 1997). Despite the benefits, mariculture alters social relationships in communities and households. In the case of some farmers who previously had little experience with cash income, having cash makes them feel proud and some may become arrogant. This may cause social tensions.

2.3.4 Community participation as a means to increase benefits and reduce impacts from mariculture development

Maximizing the direct benefits that a community receives and minimizing negative socioeconomic impacts depends largely on the importance given to community participation. Failure or success of mariculture development may hinge on this factor.

A participatory, integrated management approach provides a means to involve the community from the initial stages of planning through implementation, imparting a sense of ownership and responsibility.

It is very important to involve the community from the planning stages through implementation of mariculture operations. People need to be involved at cognitive levels to allow them to think about how to plan, manage and control their resources. Experience has shown that projects that are not accepted by the community, and consequently fail, are often those where the community members were not involved in planning and management. Lack of community participation can also result in breakdown of social structures of the communities, conflicts, marginalization and displacement of the people.

There are a few examples of mariculture operations in Tanzania that have failed because of lack of community participation. On Mafia Island and in a village in Mtwara, seaweed farming was being conducted in a manner that allowed the owners of the seaweed-buying companies to own the farms and employ villagers to work for them. The villagers were paid salaries. These two initiatives collapsed because of conflicts over issues like delays in salary payments (Msuya, 1995).

Generally, there is lack of community participation in Tanzania because of the top-down mode of operation that was previously common in the country. One area of strong participatory activity is the community-level process for allocation of land (discussed in detail in Section 3.1.3). Supporting and strengthening this process will enhance the opportunities for communities to share in the benefits of mariculture development.

Community participation has improved, making the implementation of mariculture operations much easier. Recent initiatives by different organizations such as RIPS, the Mafia Island Marine Park, Rufiji Delta non-governmental organizations (NGOs), the government and community-based organizations (CBOs) have improved participation. Examples of successful mariculture operations with participatory elements include seaweed farming on Zanzibar and mainland Tanzania (Msuya, 1996 a, b).

Whereas only few examples of mariculture successes exist in Tanzania, there is freshwater aquaculture in some regions including Morogoro, Ruvuma, Mtwara and Mbeya. It is reported that there were between 8,000 and 10,000 fish ponds in Tanzania by 1988 (Msuya, 1992). The activity is generally done on a part-time basis, leading to low returns in terms of cash, but farmers use the fish for home consumption (Balarin, 1985; Msuya, 1992, Seki and Maly 1993). This success is, in part, the result of community-based technical assistance and the inclusion of local people in planning and implementation.

Needs

Community participation is a critical factor in the success of delivering effective technical assistance. Planning and promoting of mariculture should incorporate a participatory approach to enhance the chances of adoption and to maximise benefits to the public.

Equally important is to formally involve the public in the legal approval process of projects and land acquisition. Top-down decisionmaking should be avoided since this short-circuits the participatory process and increases the chances of resource user conflicts.

2.3.5 Other social constraints

Cultural issues

Traditions, social attitudes, culture and other societal norms influence the likelihood of successful mariculture development. Participatory planning will reduce chances of failure caused by unforeseen factors disrupting the course of projects.

Traditional food habits and ethnic and socioeconomic patterns of some people compel them not to include fish or other mariculture products in their diet. This must be considered when planning mariculture development.

Gender issues

Gender roles affect development and management strategies. Opportunities and constraints presented by gender roles should be considered when planning mariculture development. Where possible, constraints working against participation of one gender or the other should be addressed.

Most critical gender issues revolve around factors that exclude women from economic, educational or social opportunities. Women can be among the early adopters and main beneficiaries of the industry, and contribute significantly towards the earnings of the

family, as in the case of seaweed farming in Zanzibar (Pettersson-Löfquist, 1995). It is predicted that women will have a crucial role to play in expanding coastal aquaculture in Tanzania to include food products such as finfish, oysters, prawns and cockles (Kayombo, 1986).

In some cases, it may be difficult for women to participate in mariculture if it requires breaking social taboos such as touching nets or fishing gear, working closely with male extension agents, traveling, or handling financial matters. These concerns must be addressed on a case-by-case basis.

2.4 Technology Creation and Transfer for Mariculture Development

2.4.1 Raising awareness

Most Tanzanians are unaware of the potential of mariculture as an alternative to traditional economic activities.

Promotion of mariculture is hindered by the fact that Tanzanians traditionally have little experience with mariculture. Social attitudes and attributes such as marine species preferences, taboos, lack of technical knowledge, and risk factors such as theft and



Women will have a crucial role to play in the expansion of mariculture in Tanzania.

Needs

Planning of mariculture projects must include social and cultural considerations. Both men and women should be included as fully as possible in economic development activities. A participatory planning process ensures that the concerns or special needs of the stakeholders are heard and considered.

vandalism, make it difficult to promote sustainable mariculture operations.

These constraints can be partially overcome by raising awareness

among coastal communities. Awareness campaigns can be in the form of disseminating information, providing simple and adaptable technology models, and providing long-

term technical assistance. Research institutions like TAFIRI and IMS, and training institutions such as Kunduchi, Mbegani and various NGOs have a major role to play in raising awareness in this respect.

Awareness building is necessary, but not sufficient, to effect changes in behavior or adoption of new technologies. After taking the first step by creating awareness, successful adoption and implementation of mariculture requires long-term technical and financial support. Community participation is also required. Awareness raising must occur among all sectors of society including policy makers, researchers, educators and others, in order to make large-scale changes.

Coastal management projects such as TCZCDP and RIPS have proven to be successful in raising awareness and introducing seaweed farming to Tanga, Lindi, Mtwara and Kilwa. In Lindi, Mtwara and Kilwa, awareness campaigns were conducted by organizing a participatory workshop in which the villagers explained their feelings about dynamite fishing and alternative economic activities (RIPS, 1995). One of the alternative economic activities was seaweed farming. From the workshop, a video program was produced and shown to villagers, researchers and policy makers, followed by implementation of seaweed farming in the Mtwara, Lindi and Kilwa districts (Msuya, 1995, 1996a).

Considering the limited experience with mariculture in the country, few people are aware of the potential benefits that mariculture can offer. Internationally, as mariculture technology is rapidly expanding and improving, there are now more species and systems that may be suitable for adoption in the country. More information needs to be made available so that mariculture's place in the overall development scheme can be evaluated.

2.4.2 Research and development of mariculture technology

Research and development activities for mariculture in Tanzania are minimal compared to the potential benefits. Mariculture has a low priority in the national planning scheme and consequently funding for research is scarce.

The history and experience of mariculture in Tanzania are brief. As a form of development, mariculture is accorded a low priority in the national plan and allocated little funding. This has led to a very slow pace in technological advancement, research and development.

There is a general lack of resources, human and otherwise to fully address the research issues of mariculture development.

There is a lack of trained personnel at all levels, from researchers to field extension workers. This is due in part to the lack of funding for research and training, and partly due to lack of opportunities to train for and hold careers in mariculture. Research facilities are inadequate and often unavailable outside urban areas.

Failure to coordinate research efforts and prioritize research objectives has resulted in a partial and fragmented database to support mariculture development.

Research priorities and directions are determined in isolation by the various institutions, researchers and donor agencies, with the result that systematic and sufficiently comprehensive research was not conducted for any one mariculture species or system.

Due to the limited resources available, research activity should be confined to a few proven species. Both basic and applied research must be relevant and useful for the development of mariculture in the country. Research and development should be oriented towards developing appropriate technology (FAO/UNDP 1987). Potential exists for the transfer of successful mariculture experiences from foreign countries.

Emphasis on applied research to adapt proven mariculture species to local conditions would be a more efficient use of limited research funds. For example, the technology for seaweed farming was successfully transferred from the Philippines to Tanzania using this approach.

Needs

There is a need for awareness-raising campaigns at all levels to increase understanding of the benefits and possible risks associated with mariculture. Awareness raising must be followed by long-term technical and financial support to successfully transfer mariculture technology. Part of the awareness-raising process is to study experiences with mariculture development and policy from other countries and within the nation, and select suitable elements for adoption and implementation.

Potential exists for the transfer and refinement of successful mariculture experiences within the country.

A priority should be placed on applied research to adapt, replicate and refine technologies proven within Tanzania, rather than initiating new research efforts. Seaweed culture was demonstrated to be feasible in Zanzibar, but more applied research and extension is needed to improve and transfer the methods.

Donor support for research and development can be used more effectively.

Many of the research and development efforts are supported by foreign donor technical assistance and financial support. Coordination of research and development would allow more effective use of these resources at a national and local level. This will require a commitment from donors to communicate with each other and with the appropriate national institutions.

2.4.3 Issues for mariculture technology in Tanzania

It is unclear which species offer the greatest potential benefits for mariculture development.

In general, baseline data on mariculture practices and appropriate models for species other than seaweed are inadequate.

Appropriate technology for seaweed farming was developed and successfully adopted by local communities along the coastline of Tanzania. More study and analysis are needed in order to determine which species should be prioritized for promotion and development in Tanzania.

It is unclear which systems and levels of technology should be the priorities for Tanzanian development.

Needs

Mariculture should receive a higher priority in the national planning scheme in recognition of its potential benefits for the nation. This will provide the mandate for increased human and financial resources to strengthen the capacity for mariculture research and development.

At the same time, there is a need to make more efficient use of available resources by establishing priority research objectives and coordinating research efforts between various institutional stakeholders. Applied research into appropriate mariculture technology to develop models for local adoption should be the emphasis for research and development efforts. Applied research must be linked to extension that would enable the public to benefit from and adopt research findings. Extension effort should learn from international and national experiences in mariculture and adopt useful models for local use.

Donor support could be more effectively utilized if the objectives of applied research and the use of funds were guided by intersectoral coordination and collaboration.

There are a number of opportunities for introducing mariculture systems, from the small-scale subsistence level to the large, commercial scale. Given that resources of all types are limited, development of these systems needs to be prioritized.

It is unclear which mariculture systems and operating procedures represent the best choices for optimizing production levels and benefits while minimizing environmental and social impacts.

Given that the mariculture industry is still new in Tanzania, there is an opportunity to avoid mistakes made in other nations. Careful consideration needs to be given to the strategies and methods used to develop a mariculture industry.

It is unclear whether the technology and infrastructure base exists or can be developed in Tanzania to permit feasible mariculture development.

Mariculture depends on having a suitable technology base on which to build. This technology base includes having sufficient numbers of skilled people, research and development facilities, infrastructure needed to support business development, and support from the public and private sectors. It is not clear whether the present level

of technology and infrastructure existing in Tanzania would allow mariculture to develop past the point of supporting more than a few small-scale, scattered projects. Of particular concern is the availability of seed (juveniles), formulated feeds, drugs, processing facilities, refrigeration/freezing facilities, export capability and technical personnel. Infrastructure for transportation and communication is also lacking. These are discussed in more detail elsewhere in this document, but given the inadequacy of the technology base as a whole, the need for an intersectoral approach to mariculture planning and implementation is clearly indicated.

Needs

With so many available options, and such limited resources, a means of analyzing and choosing objectives for mariculture development is needed.

Strategic analysis of feasible options and elaboration of a development plan for mariculture is required to efficiently implement mariculture development.

Complete analysis of the technology and infrastructure available for development of specific forms of mariculture should be used to formulate a development plan's objectives.

An important gap in the current technology base for mariculture is the framework for monitoring. Monitoring methods, criteria and procedures, with mechanisms for feedback to regulatory and management institutions, need to be developed.

Monitoring mariculture projects, including collecting baseline data before construction is recognized is important, but monitoring criteria and plans are not formulated. Trained personnel and resources for monitoring are limited.

Monitoring is a critical tool that allows mariculture operators to assess the impact of mariculture projects and improve management of their ventures. Strategies for monitoring mariculture facilities and the surrounding ecosystem are needed if mariculture is to expand.

2.4.4 Extension and technology transfer

Extension is the vehicle to transfer information and capacity to conduct mariculture and, as such, is key to economic development. Extension as practiced in Tanzania currently involves the transfer of knowledge from experts to farmers, fishers or crafts workers. Agricultural extension is defined as “a service or system which assists farm people through educational procedures in improving farming techniques, increasing production efficiency and income, bettering their levels of income, and lifting the social and educational standards of rural life.” (Maunder, 1972).

Development of mariculture will depend upon developing the capacity to effectively transfer knowledge and methods. There are several constraints to achieving this.

Available Technology Limits the Scale and Profitability of Mariculture

Seaweed farming is an example of a form of mariculture requiring little technology and operating on the smallest scale. However, even this relatively simple form of production can be limited when adequate technology and processing do not exist.

Seaweed farming offers the opportunity to focus currently available technical assistance on a form of mariculture that has proved successful. One possible development strategy would be to improve and strengthen the seaweed culture industry rather than diversifying into other forms of mariculture, thereby overextending the already scarce technical resources.

Production and harvesting activities must be technically sound to ensure quality products. Seaweed is usually spread on locally woven mats, coconut tree leaves and on grass to dry in the sun. Seaweed producers face a number of challenges in producing high quality, clean, dried product including lack of drying facilities near their homes, lack of transport for wet product and lack of training in handling procedures. Sub-optimal quality affects the price they receive.

Extension officers have not yet developed and promoted improved methods for cleaning and drying seaweed. Observance of quality standards in Tanzania is in the hands of the Tanzania Board of Standards, yet at the moment, it plays no appreciable role in ensuring quality standards for mariculture products. This is a relatively simple case. Similarly inadequate technologies are expected to hamper mariculture production and sales for other species, unless they are foreseen and addressed in early stages.

Given the current institutional arrangements, mariculture extension could be carried out by different institutions at various levels, resulting in a lack of coordination and direction.

Freshwater aquaculture is under the direction of the Division of Fisheries. Mariculture comprises only a very small part of the work of this sub-section of the ministry.

While extension is supposed to be coordinated at the local level, most expertise exists at the national level, centered in Dar es Salaam. Agricultural extension, the strongest extension capability within the country, exists in the Division of Agriculture.

Given the multidisciplinary nature of mariculture, it is not clear which institution would ultimately be the most efficient vehicle to deliver mariculture extension services.

It is clear that mariculture extension should be implemented under one coherent and comprehensive mandate and executing agency which draws upon the expertise and experiences of other sectors where needed.

Fisheries plans do not specifically address aquaculture for coastal areas.

Lack of a specific plan for mariculture tends to cause institutional neglect and hinder development of a strong extension capability. Extension efforts need to be directed by priorities and objectives established by a process of intersectoral planning and coordination.

Extension addresses multidisciplinary questions in economic development. Effective extension requires the integration of applied research and training in a feedback loop that incorporates field

experiences. The current lack of intersectoral coordination will prevent an integrated extension system from developing.

Needs

Mariculture extension can be strengthened through development of objectives and mechanisms that are specified in relevant sectoral policies. Given that mariculture is a multidisciplinary field with links to many sectors, intersectoral and inter-institutional coordination is needed for successful mariculture extension. An effective approach to mariculture extension would be to develop a cooperative research and extension capability based on a multisectoral, multidisciplinary approach that includes participation of researchers, educators, extension workers, business experts and clients.

Increasing communication and collaboration between national level and district level personnel would assist researchers and extension workers in sharing their experiences and expertise.

The current extension efforts underway can also be strengthened through increased funding to provide the means and resources for extension workers to carry out their jobs, particularly at the district level.

Extension activities require knowledge and expertise drawn from many disciplines such as biology, agriculture, economics, education and research. Transfer of technology also requires that researchers, extension workers, educators and clients collaborate to progressively test and refine

methods. It should incorporate a feedback mechanism to the experts so that they may adjust their technologies to meet local requirements and conditions. Without intersectoral cooperation, planning and funding, mariculture extension efforts will remain focused on isolated components of the problem.

Funding for extension and training is inadequate.

Lack of funding limits the opportunity to provide training to students and extension workers in this field. Extension workers also lack basic requirements for doing their job, such as transportation and materials.

There are insufficient numbers of extension workers to meet the demand for technical assistance.

In part, this is a result of lack of funding, but is also due to the difficulty in attracting and training students. Incentives must be such that professionals are able to find jobs, and are willing to remain in non-urban areas doing this difficult work.

2.5 Financing Mariculture Activities

2.5.1 Private sector

Inability to obtain loans impedes local investors and community members from starting mariculture ventures.

Fluctuation in supply from capture fisheries provides investment opportunities in mariculture activities. Tremendous demand is observed for the seaweed business, and there are large-scale investment proposals for prawn farming in Rufiji Delta and Bagamoyo. However, the poor state of the Tanzanian economy presents unfavorable conditions for national financial institutions to extend loans to large-scale commercial operations such as prawn farming. Small- and medium-sized mariculture operations also cannot begin due to stringent conditions imposed on loan applications. Foreign financial institutions are also reluctant to fund mariculture ventures because of the perceived risks associated with mariculture.

Joint ventures between foreign investors and local partners are the driving forces behind the recent growth of mariculture.

With the introduction of trade liberalization, the business community in Tanzania shows interest in investing their money in mariculture and is generally backed by foreign companies or capital. Three companies, Zanzibar East African Seaweed Company (ZANEA), Zanzibar Agro-Seaweed Company, Ltd. (ZASCOL) and C-weed Corporation (Kingsway International) are involved in seaweed farming (Msuya and Mmochi, 1995). There are proposals for large-scale commercial prawn farming in Rufiji by African Fishing Company, and in Bagamoyo by Prawntan Ltd. and Grammack (T) Ltd. (Kalangahe, 1996). On the Zanzibar Islands there are a number of business people who asked for technical advice for mariculture of various species, in areas such as Pete, Kiuyu, Paje and Zanzibar town, among others (Mmochi et al., 1996, 1997).

However, these investments present relatively insignificant development opportunities comparable to the available potential along the coast that could be developed if loans, particularly small loans, were available. Since loans are not available, Tanzanian investors or community members without backing from foreign interests have little opportunity to start mariculture businesses.

2.5.2 Public sector

As mariculture falls under a sub-section of the Division of Fisheries, little budget is specifically allocated to any mariculture needs. The public sector also lacks funds to support other activities that are needed for mariculture development such as infrastructure development and training.

Lack of funding for development activities is a general constraint in Tanzania. Some improvement may be seen if donors and private investors are encouraged to see mariculture as an attractive, not risky, endeavor. This can be enabled by supporting sustainable forms of mariculture through guidelines, policy, regulations and development planning.

2.5.3 International donors

Donor funding for mariculture will be more readily available once the legal and institutional basis for sustainable mariculture is assured.

Given the lack of private and public sector funding, one alternative is to solicit funding from multinational organizations such as The World Bank and Commonwealth Development Corporation. Due to financial and environmental risks associated with the lack of proper mariculture policy, guidelines and regulatory framework, very little progress was made in getting funds from these organizations.

Donor funding that is currently available can be used more efficiently.

More efficient use of donor funding requires a joint effort on the part of the donors and national institutions. Government personnel and institutions should be seen as one of the potential clients in all donor projects, as they represent a permanent presence in the country. Strengthening the technical and management capability of the public sector helps promote long-term sustainability of projects after donor aid is withdrawn. Equally important is that public sector personnel take the initiative to document, learn from and replicate positive experiences that occur in the various donor projects.

Needs

Given that mariculture is often perceived as a risky enterprise, demonstrating the economic feasibility and environmental sustainability of mariculture may help encourage lenders and donors to provide credit or grants to prospective aquaculturists. Demonstrating the viability of mariculture could be achieved through pilot demonstrations and economic feasibility studies.

Needs

Joint ventures between Tanzanian and foreign investors are one of the few means of obtaining capital to finance mariculture ventures. Independent national entrepreneurs and villagers need sources of credit in order to be included in mariculture development.

Current resources allocated for mariculture development by the public sector and donor projects could be used more efficiently if closer communication and collaboration existed within the public sector, and between government institutions and donor agencies. Joint planning and implementation of objectives for both mariculture development and the use of resources would avoid duplication of efforts or implementation of projects in isolation.

Increased funding through grants and loans can be encouraged by developing and implementing guidelines and regulations that promote the economic and environmental sustainability of mariculture, thus reducing the perceived and real risks of mariculture.

2.6 Post-harvest Technology and Marketing

2.6.1 Post-harvest technology

All stages of post-harvest technology are significantly underdeveloped in Tanzania and operations producing amounts of product which exceed the immediate needs of local consumption may face loss of product.

Needs

More analysis of the post-harvest requirements of mariculture is required to determine which types of mariculture can be effectively promoted given the relative lack of infrastructure and technology. Strengthening of some components of these may need to precede implementation of certain types of mariculture, particularly those that are large-scale and technology-intensive. These considerations should be included as part of an overall mariculture development plan.

Larger urban areas have some limited capacity to process, handle and provide refrigerated storage for mariculture products. Commercial-scale processing of cultured fish or prawns may be beyond the capacity of existing facilities. Outside the large urban areas, difficulties will be encountered in obtaining rapid transport to existing facilities and markets. Processing, storage and shipping facilities will need to be created as part of commercial-scale projects. Equally important will be developing the human capacity to operate and manage processing facilities to ensure safe and high quality products for local and international consumption.

2.6.2 Market trends

Tanzania is currently producing seaweed that is exported to Denmark, France and the United States. Market data show demand is growing. International demand for other cultured species, such as prawns, sponges, oysters and crabs, is also showing a steady increase.

Perceived demand for mariculture products at the global level, and to some extent, at national levels, inspired scholars and researchers to assess the aquaculture potential of coastal Tanzania. The mariculture potential of prawns along the Tanzanian coast, especially of the species *Penaeus monodon* and *P. indicus*, was described in Ibrahim (1976), Singh (1976), and Balarin (1985). The mariculture potential of marine finfish is not fully documented, but attempts to culture rabbit fish (*Siganus canaliculatus*) are reported by

Bwathondi (1981). Other observers, Mshigeni (1992), Balarin (1985), and Bwathondi (1986), have described the aquaculture potential of shrimps, oysters (*Saccostrea cucullata*), milk fish (*Chanos chanos*), and seaweeds, especially those of the genus *Eucheuma*, e.g. *Eucheuma spinosum* (*E. denticulatum*) and *E. cottonii* (*Kappaphycus alvarezii*).

Seaweed

A downward market trend for Eucheuma denticulatum (E. spinosum) was observed, along with a drastically rising market trend for Kappaphycus alvarezii. Therefore, diversification of seaweed culture may be advisable.

Production of seaweed so far has not met the external demand for it. Seaweed from Tanzania is exported to Denmark (Copenhagen Pectin A/s), the United States, (FMC) and France. Local companies working in partnership with these companies are ZANEA, ZASCOL and C-weed Corporation. There are also individual businessmen who are becoming increasingly interested in purchasing seaweed, especially in southern regions of Tanzania. It is reported that there are a number of foreign companies seeking partnerships with established local companies to buy even more seaweed from Tanzania. There is now an enormous demand for the two seaweed species in the world market, where the dried plants are extracted to yield carrageenan. However, with the increasing demand for *K. alvarezii* compared to *E. spinosum*, growers should consider switching their production to the former species.

Other markets

The demand for marine finfish in the future will not be met if exclusive dependence on capture fisheries continues.

It is apparent that globally, culture of species such as rabbit fish, oysters, milk fish, mullet, shrimp and brackish water tilapia are going to supplement the already dwindling fish catches from the sea. Demand for fish and seafood products by coastal people will continue to increase, and it is expected that an internal market exists for mariculture products that are currently popular (e.g. finfish, shellfish and crustaceans).

Local demand for less popular mariculture products such as clams and oysters will require a popularization scheme at the local level.

Although probably not a good choice for immediate promotion in most communities, these products may meet demand in tourist hotels. There is a positive market trend for mariculture products that can be consumed locally and nationally, and there is room for an export market. Obstacles such as storage and transportation must still be addressed.

2.6.3 Need to assess market potential

Markets for mariculture products should be well known before any activity starts. Due to a lack of a comprehensive marketing study assessing the potential to supply international and internal

markets, decisions regarding target species and sizes of culture projects will be unwise.



If products are accepted by local communities, marketing becomes easier. Acceptability also makes a mariculture operation sustainable. If a product is rejected by the community, a mariculture operation may be forced to stop. Export marketing is more demanding than supplying the local market and needs to be examined thoroughly.

A mariculture product such as seaweed must satisfy the buyer's standards to maintain a business trade.

A mariculture product has to satisfy the importer's standards in order to sustain business, even if a high external demand exists. Poor quality of a mariculture product may lead to rejection of a product in the export market. Understanding quality standards and implementation of quality control is needed to assure that locally produced products can be exported.

Information on market trends helps producers and government make decisions regarding development. For example, knowledge of international and local prices for seaweed tend to suggest that there may be a monopoly on seaweed marketing that tends to depress local prices. In Tanzania, markets for seaweeds are only export markets as

seaweed is farmed as a cash crop. Price per kilogram paid to farmers is Tanzanian shilling (Tsh.) 100 for Zanzibar and Tsh. 80 in mainland Tanzania (Msuya, 1996b), whereas the world market stood at US\$ 450 per tonne in 1994. Although international prices rose to US\$ 500 per tonne in 1996, and the value of the shilling dropped, local prices paid to producers remained the same.

Markets for other mariculture products such as finfish, shellfish and crustaceans are expected to be both local and international. The tradition of eating fish by communities living near water bodies, and the availability of tourist hotels offer great potential for local markets of mariculture products.

2.7 Infrastructure and Industrial Capability Supporting Mariculture

Problems with infrastructure, including roads and other transport, port facilities, electrical power and telecommunications, are a fundamental and underlying issue in almost all aspects of development in coastal regions. Infrastructure has a major impact on all economic activities (Map 3).

2.7.1 Ports and harbors

Ports and harbors with the capacity to ship refrigerated containers to Europe, Asia, Africa and North America can serve as a means to export mariculture products, although shipping is slow.

The coastal regions have major harbors at Tanga, Dar es Salaam, Lindi and Mtwara. Dar es Salaam is the main harbor handling cargoes for most of its regions and neighboring landlocked countries including Malawi, Zambia, Rwanda and Burundi. The handling done at the harbor was recorded at a total of 3,931,781 tonnes in 1995/96.

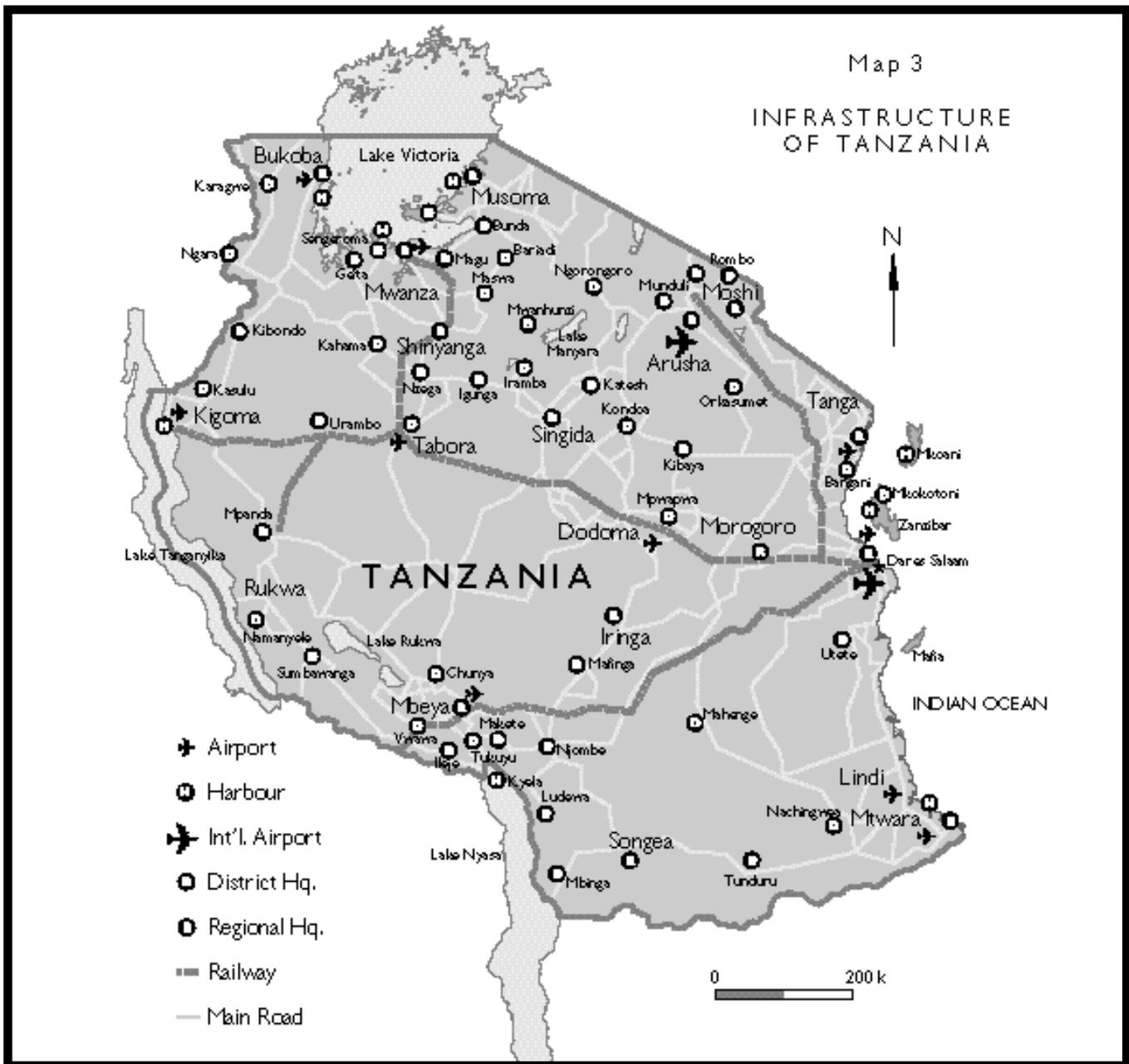
Needs

The immediate need is a careful analysis of market trends and potential for the growing seaweed industry. This work can serve as a model for future analysis of market trends and potential for non-seaweed species before promotion or development is attempted. Additionally, a market study of international and local markets could provide critical information to help determine objectives for a mariculture development plan.

2.7.2 Roads and railways

Some internal shipping can be done within Tanzania, but poor road conditions and long transportation times will pose severe constraints to transporting perishable products.

Roads in coastal districts are often impassable during the rainy season. Not all coastal areas, especially in the south, are easily accessible by road. Additionally, transport costs



are estimated to be in the range of Tsh. 650 per kilometer, making the cost of transporting mariculture products prohibitively high.

Production of any mariculture product that must be sold outside its immediate vicinity should be considered in light of high shipping costs and slow transportation times.

2.7.3 Communications

Communications in outlying areas will impede operation and coordination of commercial mariculture projects. The ability to communicate clearly and quickly is required for timely shipment of supplies and equipment, coordination of harvesting, marketing product and gaining access to technical information.

2.7.4 Industries

The industrial capacity of the coastal region is low, but some industries can partially support mariculture activities. Strengthening of the industrial sector is required for large-scale mariculture, which in some cases may help spur this development.

Seventy-five percent of the nation's industry is located in the coastal region. Food processing and canning plants, whether currently used for fish, fruit or other products may potentially be used to process mariculture products, depending on the amount of retooling necessary. These include a fruit canning mill and cashew nut processing plants in Kibaha and Mtwara, oil processing mills in Lindi, and sisal processing facilities in Mtwara.

Construction materials such as cement from Dar es Salaam and Tanga, and timber from Mkata and Lindi are available. Mills producing chicken feed operate in Dar es Salaam and Zanzibar. Cotton mills in Bagamoyo and Rufiji can produce cottonseed meal and oil for aquaculture feeds. A sisal factory makes ropes that can be used in some types of mariculture. Nets and other fishing equipment and supplies are made in Dar es Salaam and are also imported.

Needs

Careful analysis of the needs of a growing mariculture industry for infrastructure and associated industries should be conducted and considered in mariculture planning.

Chapter three

LEGAL AND INSTITUTIONAL FRAMEWORK

3

3.1 *Institutional Framework*

3.1.1 *Position of mariculture in the government of Tanzania*

Mariculture has a low priority in national planning which resulted in lack of attention to development of this industry. The Division of Fisheries (Ministry of Natural Resources and Tourism) is responsible for mariculture at the national level. The Division of Fisheries places an emphasis on extension support to freshwater aquaculture. Local government is responsible for coordinating aquaculture extension at the local level, but district level fisheries officers rarely focus on mariculture issues. Funding and staff support are very limited at both national and local levels.

The organizational structure of the Division of Fisheries has undergone a number of changes over a period of years, but Aquaculture and Extension Services has always remained as a specific sub-section (see Figure 3.1). Aquaculture and Extension Services primarily focuses on freshwater aquaculture, and secondarily on mariculture.

The Fisheries Division does not extend to the districts administratively under the decentralization system, and has no staff in the districts. District Councils, and district-level fisheries officers, are responsible for mariculture at the local level. However mariculture does not have a specific organizational structure at this level (Fig. 3.2). It may be considered as an ad hoc activity in particular areas with specially funded programs or projects (e.g. alleviation of malnutrition, community food security). At the district level, mariculture receives little attention, due to a variety of factors, in addition to the lack of specific organizational structure.

Although mariculture and capture fisheries are overseen by the same institution, there is a significant difference in the degree of emphasis given to capacity building, creation of awareness and prioritization for the different fields.

Although both fields deal with management of aquatic organisms, conceptually the topics are rather distinct. Capture fisheries are economically more important at the moment. The low status of mariculture is not a question of its potential, but is a result of lack of awareness at the various institutional levels. It has not been given attention at any level in national development planning and has a restricted allocation of resources for its development.

In many countries, responsibility for aquaculture is assigned to the institutions responsible for agricultural research and extension.

Aquaculture, a crop production process, shares many similarities with agriculture. To increase support for mariculture, this may be an interesting option for Tanzania. The extension programs in agriculture are better developed and have greater support. At the very least, stronger institutional ties between the Fisheries Division and the Ministry of Agriculture could be beneficial in promoting mariculture.

3.1.2 Roles of institutional and non-institutional stakeholders

The development of mariculture involves many stakeholders with diversified interests, which calls for a unified, collaborative effort and approach.

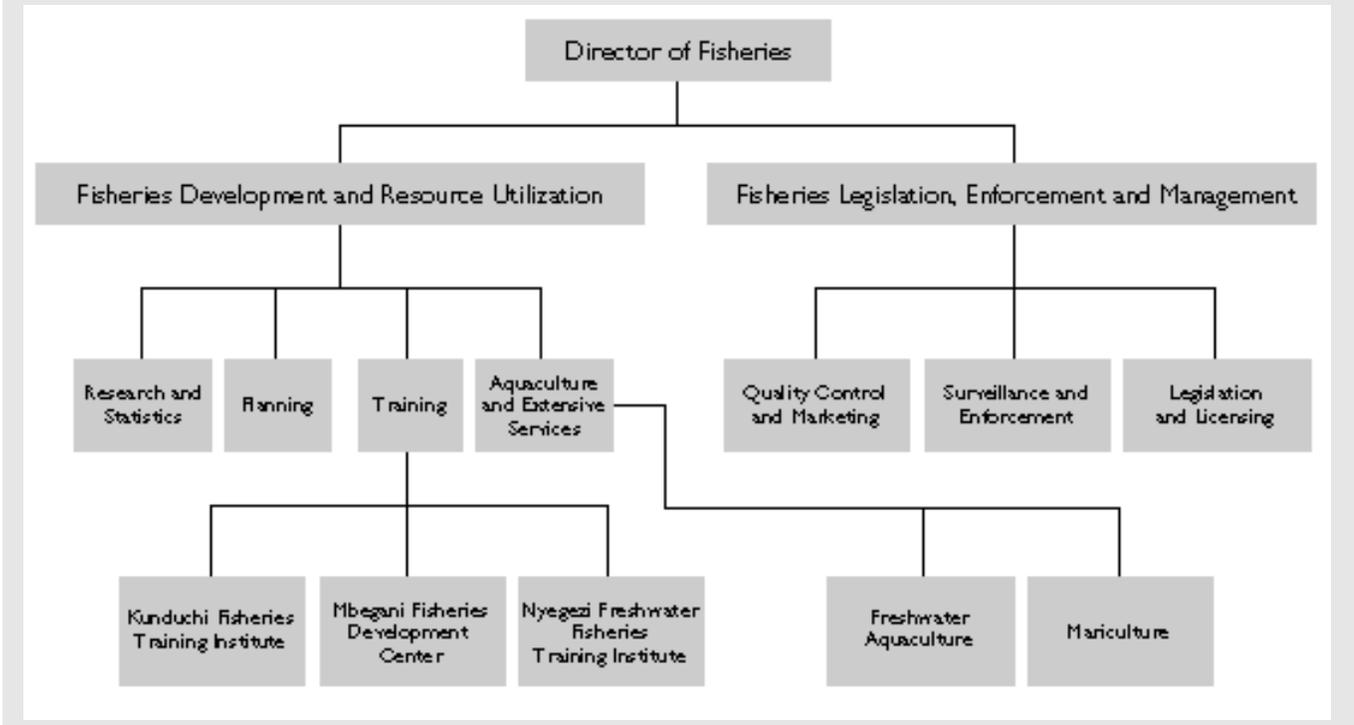
Mariculture stakeholders include all those with interests in coastal zone management and development. For the purposes of this profile, they are grouped in five categories: government institutions, local communities, private sector, NGOs, and international institutions and organizations (Table 3.1).

Needs

Placing mariculture higher up in the Fisheries Division organizational structure would increase recognition of its potential and allow the allocation of appropriate resources and autonomy. Increased funding for mariculture is needed if mariculture development is to proceed at a reasonable pace. Integration of national and district-level development objectives, capacities and responsibilities is needed in order to increase support for district-level fisheries officers so that progress can be made in mariculture development need support to make progress.

Figure 3.1

Organization Structure of Fisheries



Lack of a formal forum or mechanism for integrating the concerns and interest of various stakeholders can result in conflicts that damage the private and public sector.

Many of the institutional stakeholders concerned with mariculture activities have widely differing interests in mariculture development, while other stakeholders who should be involved may have no formal tie to the sector. In the case of the institutional stakeholders, this is reflected in the lack of sectoral integration in addressing questions of mariculture development and management. The general lack of an intersectoral approach, no forum for expressing shared interests, unclear development guidelines and procedures, and attempts to streamline decisionmaking resulted in a large national and international debate over approval of the Rufiji Delta shrimp mariculture project.

The present system is typified by lack of communication and coordination between all stakeholders. Difficulties caused by the lack of intersectoral coordination between institutional stakeholders are

further exacerbated by the lack of communication and coordination between the non-institutional stakeholders, and between public and private sectors.

The means of dealing with mariculture and environmental issues are poorly defined and this opens the door for conflict. The private sector finds it difficult to discover what is needed to legally start a mariculture business and to navigate through the required procedures. On the other hand, the sections of the public sector responsible for permitting mariculture operations are reluctant to do so, since there are few institutional means for evaluating the costs-benefits of operations or preventing impacts. The result is that mariculture development is slowed and lags behind that of other countries.

International organizations and NGOs tend to plan and execute their work in isolation, further adding to the lack of coherency in planning development activities.

Stakeholders from donor institutions can play a positive role in providing technical assistance, guidance and financial support for development projects in areas such as fisheries, aquaculture and the environment. However, their resources and inputs could be put to more efficient use if they placed more emphasis on increased coordination and consultation with other stakeholders, both public and private.

Coastal development projects, including mariculture, are approved on a “first come, first served” ad hoc manner, with little regard for future development. Development plans for particular areas and communities are prepared and carried out by different

Needs

A mechanism which allows various stakeholders have an opportunity to participate in mariculture project planning and approval for both large- and small-scale mariculture is needed. Particularly in the case of large-scale projects, opportunities for the public to comment on land tenure issues, EIAs, the project approval process and allocation of resources will increase transparency and help ensure social acceptability of proposed projects. Increased communication between the public, the private sector and responsible institutions is needed in order to resolve conflicts.

Since mariculture is a multidisciplinary, multisectoral field, close coordination in the planning, regulation, and research and development of mariculture is required to realize its full potential and avoid negative impacts. Institutional stakeholders should be encouraged to work towards developing means of increasing intersectoral coordination for planning and development.

As development intensifies along the coast, competition between different economic activities for the same resources can be prevented by establishing land use criteria and plans that harmonize multiple uses.

International donors should recognize the need to coordinate and collaborate with all levels of government and concerned stakeholders to ensure that their influence on development is sustainable and culturally acceptable. There is a need to prioritize and coordinate funding from the private sector or international funders to gain the most effective use of limited resources.

sectors (e.g. agriculture, tourism, forestry, public health) in isolation, even when development projects and funding sources are similar, and when these activities may come into conflict. To spur investment, the Tanzania Investment Center (TIC) may approve projects without prior consultation with line ministries/sectors.

The situation may be summarized by:

- ***Sectoral fragmentation***, with the consequence that all aspects of mariculture are not adequately addressed, or related issues are addressed in isolation by different institutions
- ***Lack of coordination and planning***, so that development-related activities are not efficiently handled
- ***Territoriality in jurisdiction***, due to perverse incentives which encourage institutions to work in isolation
- ***Lack of oversight and accountability***, which can be a source of conflict, dishonesty and corruption, or simply lack of motivation

Institutional and human capacity for mariculture is low partially due to limited financial support for research, staff and activities.

There are very few trained aquaculturists. Most are employed by UDSM, the Directorate of Fisheries, Kunduchi Fisheries Institute, Mbegani Fisheries Development Center, Nyegezi Freshwater Fisheries Institute and TAFIRI (see Table 3.2). The size of the student body at UDSM and in the training centers is declining due to a lack of funding to support operating costs.

Apart from UDSM, the remaining national training institutions cater to training fisheries extension staff for dual roles in aquaculture and fisheries management. The level of technology and experience offered in the national fisheries training institutions is low and mostly confined to small-scale fish farming, particularly tilapia culture. Therefore, local expertise for intensive operations and culture of other commercial marine species is seriously lacking. There is a need to consolidate and improve the training and research capacity of national fisheries institutions in mariculture technology.

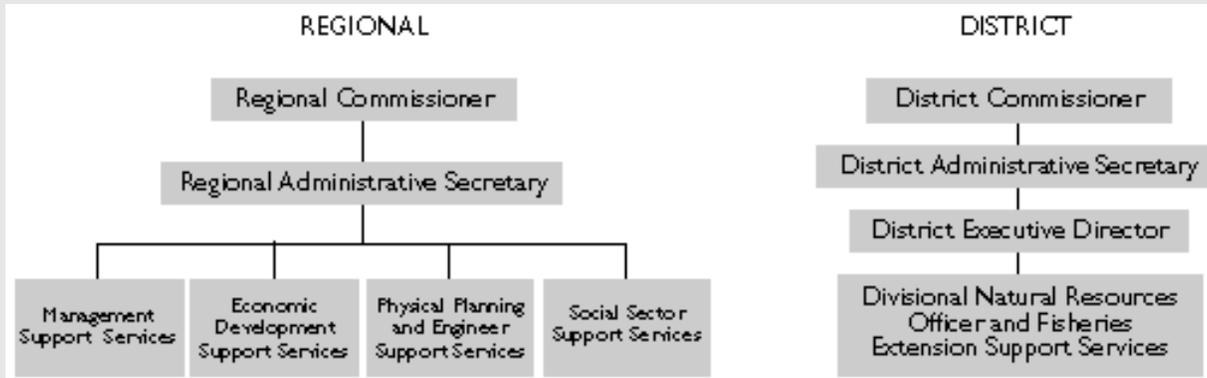
Table 3.1

Mariculture Stakeholders

Stakeholders	Mode of Participation	Direct Benefits
Government Institutions Ministries Research/ Training Institutions Parastatal Organizations Sectors/ Departments	<ul style="list-style-type: none"> • Training and research coordination • Conservation of resource base • Development of sectoral plans • Revenue collection • Oversight of rational use of natural resources • Provision of infrastructure • Creation of policy, guidelines and regulations for resource use • Monitoring and auditing • Licensing • Enforcement • Legislation • Extension services • Manpower planning and human resources development • Coordination of other stakeholders • Support of information systems • International networking • Land use monitoring and evaluation 	<ul style="list-style-type: none"> • Tax revenues • Rational utilization of resources • National development • Institution strengthening • Community development • Improved information and decisionmaking
Local Communities and Community Members	<ul style="list-style-type: none"> • Sustainable resource use • Economic development • Conduct initial stages of site allocation procedures • Environmental protection • Project implementation 	<ul style="list-style-type: none"> • Employment and income • Social services • Government revenue • Healthy ecosystem
Private Sector	<ul style="list-style-type: none"> • Investment and private enterprise • Harvesting and utilization of resource base • Testing and adoption of technology • Compliance with government regulation, guidelines, environmental protection standards, etc. 	<ul style="list-style-type: none"> • Sales and profits • Long-term economic growth • Access to markets • Reliable source of inputs (materials, staff) • Security of investment
NGOs	<ul style="list-style-type: none"> • Sustainable production and environmental conservation • Education and awareness raising • Stakeholder participation and collaboration 	<ul style="list-style-type: none"> • Community development • Enhanced planning, participation and awareness • Protection of the environment
International Community	<ul style="list-style-type: none"> • Capacity building through technical assistance, training and transfer of technology • Partners in sustainable development • Financial assistance • Compliance with international agreements and responsibilities • Development planning 	<ul style="list-style-type: none"> • Globalization/ technical dissemination • Economic development • Equity • Environmental protection • Moral and social fulfillment • Market creation for exports

Figure 3.2

Proposed Administrative Organization Structure



3.1.3 Jurisdiction of mariculture

The fact that mariculture falls under the Division of Fisheries gives this institution the largest share of authority over issues concerning its development compared to other government institutions. The responsibilities of the Division of Fisheries in this area include:

Table 3.2

Tanzania Fisheries Institutions and their Roles

Institutions	Roles	Aquaculturists
UDSM		
Zoology Dept.	Training/Research	2
Botany Dept.	Training/Research	1
IMS	Research	3
Directorate of Fisheries		
Headquarters	Administration	3
Kunduchi	Training	2
Mbegani	Training	1
Nyegezi	Training	2
TAFIRI	Research	2
Total		16

- Planning, budgeting, and submission of projects for government approval and financing
- Disbursement of funds for approved projects and project supervision
- Procurement and allocation of necessary project resources
- Initial approval of mariculture project proposals
- Establishment of development guidelines
- Authority over issuing of permits and licenses
- Formulation and implementation of policy
- Formulation of legislation and legal enforcement
- Extension services

The Fisheries Division does not have sole authority over all issues concerning mariculture. There is considerable interaction with many other sectors and institutions in the course of project planning, approval and implementation.

For example, the process of approving large mariculture projects involves the divisions of forestry, land and environment; the National Environment Management Council (NEMC); the TIC; and various NGOs. The Fisheries Division is involved initially in assessment of project technical feasibility, and after approval, in monitoring. Unlike in the capture fisheries, there are no licenses for mariculture operations except for the export of products.

The procedure for approval of commercial mariculture projects is not well defined and as a result may cause difficulties in decisionmaking, costly delays and uncertainty to investors.

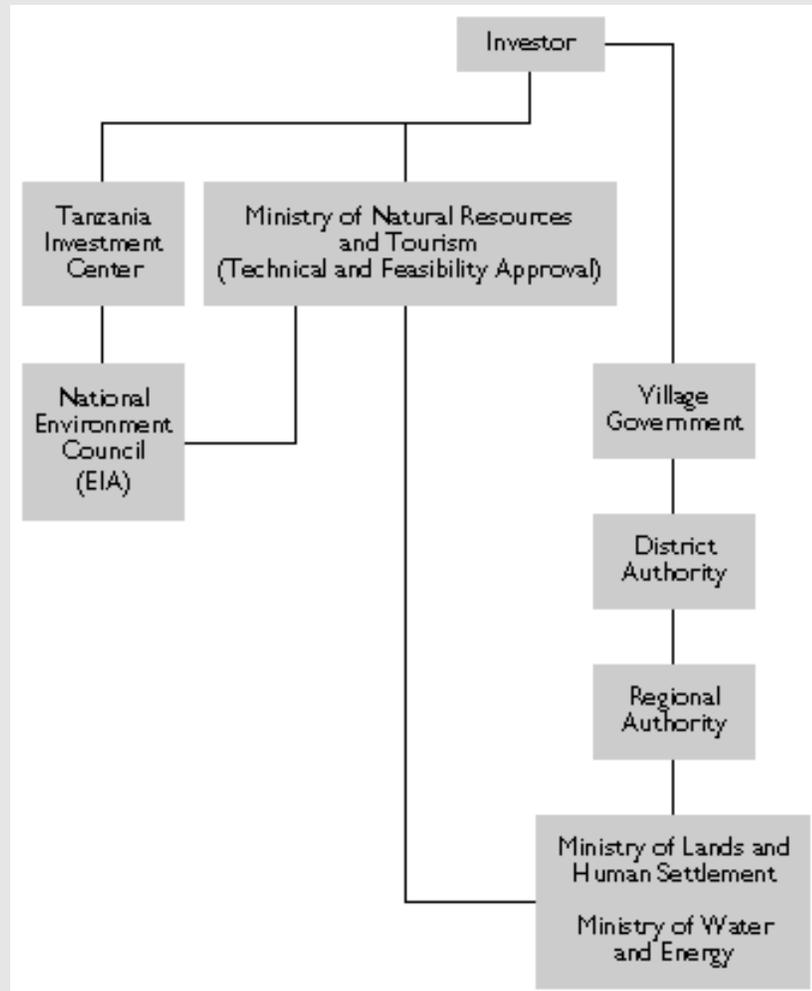
Under the present system (Figure 3.3), the investor should first submit a project proposal to the Ministry of Natural Resources and Tourism for technical feasibility and to NEMC for EIA approval. The proposal, if technically accepted, is then submitted to the TIC for an evaluation of investment feasibility. The Investment Promotion Authority of the TIC has provided criteria for investors to qualify for investment incentives.

The TIC is mandated to provide a “one-stop” approval process. Although consultation with responsible institutions is required, if no response is received after a short period of time, the TIC may issue an approval. The period of time allotted for other institutions to consider the proposal is insufficient in many cases, and no response is given. This may effectively short-circuit the intersectoral consultation process. If the investment conditions are acceptable and the TIC grants the desired tax exemptions, the investor should then seek approval of the project from the local community at the project site, and comply with the requirements of the district and regional land and water authorities.

However, most of the district and community level approval process is tied to the land acquisition process. Generally, an investor will have already obtained land before approaching the national level authorities (TIC, NEMC, Division of Fisheries). When

Figure 3.3

A Chart of the Mariculture Project Approval Process



land is obtained, the certificate of acquisition is usually granted under one of three use categories (industrial, residential or agricultural) with few other restrictions placed upon its use. Additionally, once land is granted under this system, it can then be leased to others without community-level consultation. Another complication is that few, if any, conditions are stipulated at this level for operating procedures.

Local communities should, in theory, play an important role in regulating mariculture development since site allocations are decided at the local level and are partially based on the input of community members. Often, most decisions regarding large-scale

projects with outside sources of investment are made at the top national level, which may lead to conflicts when local participation is bypassed. However, it must be recognized that consultation at the local level is time consuming, and approval by district and regional authorities can be frustrating due to contradicting and overlapping policies, regulations and legislation, hence the tendency of project proponents to expedite the procedure by appealing directly to the top level.

After approval is given and all requirements are met locally, the proposal is returned to the Ministry of Natural Resources and Tourism for final approval, and to the Ministry of Land for land entitlement.

Experience has shown that the local-level consultation and approval process is sometimes bypassed. Investors commonly submit project proposals to TIC, which then connects with relevant authorities for a more rapid issue of permits. While such a top-down approach can be quicker in the short run, it can lead to conflicts in the long run because public participation is limited. However, it is in accordance with the Tanzania Investment Act of 1997. The act states that “The [Investment Promotion] Center shall be a one-stop center for investors, the primary agency of Government to co-ordinate, encourage, promote and facilitate investment in Tanzania and to advise the Government on investment policy and related matters.” It further states that the TIC shall communicate in writing with relevant authorities to secure necessary licenses and approvals as required by the investor. Thus, the current approval process can be subverted in various ways. This is due to the existence of loopholes in the regulatory framework and lack of clarity as to the institutional arrangements relevant to this area of development. There is also no one institution that has the authority to oversee the entire process, and thus there is no means by which it can be guaranteed that applicants either understand or follow the legally mandated procedures. Additionally, while individual institutions are usually diligent in complying with their institutional mandate, there are several critical topics, such as certain types of water use, which remain outside the jurisdiction of any institution.

Approval for a project or business depends on satisfactory completion of an EIA. In practice, once the EIA is undertaken, it is more likely to function as a means of modifying a project or recommending mitigation rather than serving as outright justification for denial to proceed with a project. The precise function that the EIA process plays in the overall approval process is not clearly defined by law. Even on an informal level, the various institutions which may be involved in the EIA process have not come to terms with the execution or function of the process. Guidelines for mariculture project EIAs are only now being developed, and only a few mariculture projects have been subjected to EIAs.

Needs

The approval process should be clarified and made known to the public, government institutions, and prospective mariculture operators. A first step in clarifying the procedures would be to draft a policy statement that specifies procedures and steps in gaining approval for mariculture projects and clearly outlines the interrelated roles of the responsible institutions. Such a statement would serve as a guide to both members of the public seeking approval and to the public servants involved in the process. Assistance to prospective mariculture operators from lower socioeconomic levels in how to obtain approvals will be necessary, to allow all individuals to have equal access to the legal system.

Existing gaps in the approval process should be addressed through policy implementation and legislative actions. The public sector should be held rigorously accountable for following the established procedures. Responsibility for oversight of the approval procedure might be granted to a neutral institution to assure compliance to procedures, and as a means of facilitating intersectoral coordination. However, institutional capacity building is needed in most areas if the public sector is to be effective in carrying out its responsibilities.

The roles of the various institutions involved in the approval process need to be clarified and possibly modified to enhance intersectoral coordination. The "one-stop" approval process of the TIC is an admirable idea, but needs modification to incorporate adequate time allowances and concrete mechanisms for public participation. Real efforts must be made to consult with other public institutions responsible for permitting and promoting mariculture.

The participatory nature of the district- and local-level processes should be supported and strengthened, and extended to national-level procedures. Top-down decisionmaking that circumvents district- and local-level processes should be avoided.

Use of all resources required by mariculture (land, water, access rights, biological resources, etc.) should be subject to rigorously defined and clear permitting procedures that are evaluated by stakeholders, researchers and policy makers. When publicly held resources are privatized, public participation must be taken into account. Traditional users of these resources must be adequately compensated for the loss of these resources.

Finally, development priorities, strategies, implementation and funding should be coordinated in an intersectoral manner under a national mariculture development plan that takes into consideration local variations for each coastal district.

The investor who wishes to comply with all legalities may have a difficult time, since the steps and procedures for approval are not clear and are not easy to understand by the general public. Community members in the lower socioeconomic levels may have even more difficulties obtaining information on the approval procedure and complying with requirements.

Several parties from the private sector who were interviewed mentioned that it was difficult to discover precisely what was required of them to receive full legal approval for their operations. They had received varying and contradictory advice from the institutions they approached. Additionally, compliance is costly and time consuming. Even the land acquisition process may be unclear and this is one of the key steps in starting any enterprise. A World Bank study (Narayan, 1997) showed that 26 percent of the poor people surveyed did not understand how to obtain land. With many of the key steps in the approval procedure remaining unclear to both the public and responsible institutions, it is not surprising that controversies have arisen regarding means of developing sustainable mariculture projects.

3.2 Government Policy and Legislation Related to Mariculture

3.2.1 Sectoral policies related to mariculture

There are many sectoral policies addressing issues associated with mariculture operations. Although fisheries policy does not cover mariculture specifically, the policy statements and strategies outline aquaculture development clearly (Table 3.3).

Sectoral policies are implemented in isolation resulting in inefficiencies, conflicts, overlapping efforts and contradictions.

In order to regulate mariculture development, close collaboration and coordination by institutions and harmonization of their respective sectoral policies will be needed. The key institutions and sectoral policies are agriculture, forestry, fisheries, wildlife, land, the NEMC and the TIC. Thus far there has been no effort to integrate and clarify policies and regulations for mariculture. Several critical gaps exist in these policies and regulations that must be addressed. Lack of coordination among sectoral interests is

Table 3.3

Review of Sectoral Policies

Sector	Policies
Fisheries	<p>National Fisheries Sector Policy and Strategy Statement - 3.3.7 Aquaculture (Statements 9, 10 & 11) and Strategies.</p> <p>The Directorate of Fisheries is the body responsible for formulation of policy management and development of the fisheries sector. Currently its aquaculture development policy has the objective of increasing small-scale production, ecologically sound use of water bodies and maintenance of farm hygiene. It is stipulated that guidelines and procedures will be developed for management of the environmental aspects of aquaculture.</p>
Environment	<p>The National Environmental Policy (1997).</p> <p>Sectoral policies 45-60 require consideration of environmental concerns in the sectoral policies and programs and their coordination for sustainable development. The policy recognizes the vital role of environmental resources for the socioeconomic development of Tanzania. It stresses the need for international considerations in sectoral policies and programs and the need to coordinate sectoral policies to achieve sustainable development.</p>
Transport	<p>The Transport Policy is currently under development (1998). It is expected that the policy will address issues of disaster and spill prevention, and that standards will be formulated for transportation of hazardous and dangerous materials.</p> <p>The Merchant Shipping Act (1967) states that if a person is convicted of an offense related to spills of hazardous materials, that those individuals incurring damages due to the spill may be eligible for compensation from the responsible party. This statement could be applied to instances when aquaculture operations are damaged by an oil spill or release of other hazardous materials.</p>
Forestry	<p>The National Forest Policy (1998) Policy Statements 31 and 34 are general statements that may cover mariculture. The forest policy focuses on sustainable utilization of forest products and services, foreign exchange earnings, conservation of forest biodiversity, water catchment and soil fertility. In addition, collaboration with other stakeholders in the management of forests is indicated.</p> <p>The policy does not explicitly mention its role in mariculture activities although cooperation with other stakeholders, conservation of biodiversity, water catchments and soil fertility is implied.</p> <p>The Forest Ordinance (1957) and Forest Chapter 389 of the Laws (Principal legislation), Supplement 57, Part V addresses the protection of forests and forest products in forest and mangrove forest reserves, and sets restrictions and prohibitions within the reserves. This ordinance forbids any person, without a license or other lawful authority, to cut, burn, or damage mangrove trees in the area for any purpose. However, the management plan for the Mangrove Ecosystem of Mainland Tanzania (1991) allows for the rational utilization of mangroves on a sustainable basis, such that, mangrove ecosystems would give an enhanced contribution to the economy of the country. Among other issues, the plan addresses the value of defined mangrove management zones, each of which has different designated uses and management strategies.</p>
Tanzania Investment Center (TIC)	<p>The National Investment Promotion Policy (1996) encourages investment in various economic activities by offering incentives and involvement in joint ventures.</p> <p>The Tanzania Investment Act, Acts Supplement (1997) specifies that the TIC shall act as a one-stop permitting center for investors. It is the primary agency of the government to coordinate and facilitate investment by acting as the liaison between the investor and public institutions to obtain permits, licenses, etc. required to operate a business. Institutions have 14 days to respond to inquiries by the TIC with objections; if no objection is received, the necessary license or approval is deemed granted. If a rejection is submitted, the TIC may object and refer to the minister for a decision to approve or deny.</p>

Table 3.3 (continued)
Review of Sectoral Policies

Sector	Policies
Land	<p>National Land Policy (1995), Policy Statements 7.7.0 - 7.8.1, Coastline and Fisheries provides for land acquisition for aquaculture.</p> <p>The overall aim of the National Land Policy is to promote and ensure a secure land tenure system to encourage the optimal use of land resources and economic development, without upsetting or endangering the ecological balance of the environment.</p> <p>The land policy is very important to mariculture as it clearly states who can acquire land in Tanzania and delegates authority for granting land from the village level to the president. It states that all citizens have equal and equitable access to land. Non-citizens cannot be granted land in Tanzania unless it is for investment purposes through the Investment Promotion Act. They cannot acquire land through transfer of customary land rights by citizens.</p> <p>In addition to the land policy, the following documents define the land acquisition process and provide for a land use planning scheme for designated areas: Land Ordinance (1961), the Town and Country Planning Ordinance (1962), the Land Acquisition Act (1967) and the Land Tenure Act (1969). However, a land use planning program for potential mariculture areas along the coast is not yet available.</p>
Agriculture	<p>The Agriculture Policy of Tanzania (1983). Statements 118 & 119 requiring cooperation with other ministries including natural resources.</p> <p>The agricultural policy is the oldest, as it was promulgated in 1983 during the socialist era, and some of its stated objectives reflect the philosophy of that time. Its relevance to mariculture hinges on improvement of nutritional status of the people, quality of life, foreign exchange earning, and supply of raw materials to local industry.</p>
Water	<p>The Water Policy (1991) calls for sustainable development of the water supply and sanitation in Tanzania. The policy aims at managing and developing the water resources in a coordinated and integrated manner so as to provide water of acceptable quality.</p>
Wildlife	<p>Wildlife policy of Tanzania (1998), 3.4 – Policy Implementation Framework recognizes other sectors concerned with, or having responsibilities in, the implementation of the policy.</p> <p>The policy reiterates that wildlife resources should be protected and utilized in a sustainable manner on the basis of natural heritage (flora and fauna), fragile ecosystems, sites under pressure and endangered species, with participation of and benefits to, the local communities.</p> <p>The Wildlife Conservation Act (1974) was enacted to encourage the conservation of certain wildlife species. This act operates in accordance with the limitations and requirements of the Convention on International Trade in Endangered Species (CITES), the National Parks Ordinance and related regulations.</p>
Health	<p>The National Health Policy (1990) objectives relevant to mariculture are the provision of community needs for environmental infrastructure, such as safe water supplies, sewage treatment and waste disposal services; and the promotion of other health-related programs such as food, hygiene, separation of toxic/hazardous waste and pollution control at the household level.</p>

Needs

Given that there is no comprehensive mariculture policy, the various sectoral policies relating to mariculture must be harmonized and integrated into a single statement.

There are gaps in the various sectoral policies and regulations where mariculture-related issues are not addressed. New policies and regulations are needed to cover these areas. High among the priority areas are: permitting procedures; procedures governing access to land and water tenure; water use regulations; water quality controls and standards; monitoring guidelines and procedures; licenses addressing operational issues that affect environmental quality; strict enforcement of existing laws and regulations; and provision of oversight for the permitting process.

longstanding and will take time and a concerted effort to remedy. However, initial steps have already been taken by the lead institutions to address these questions of coordination and communication.

Not all mariculture issues are addressed by the various sectoral policies.

Several types of policy gaps exist in relation to mariculture. Certain critical issues are not covered by any policy statement. For example, the use of brackish and saltwater are not specifically mentioned in the water policy. Other policy statements may lack the degree of specificity needed to be useful in guiding management of mariculture activities. For example, the fisheries policies were formulated for freshwater aquaculture, but could address mariculture more specifically now that it has become an area of intense interest.

3.2.2 Legislation covering mariculture

There is a variety of legislation related to mariculture that is described below by sector. Procedural application and enforcement of legislation, however, was always difficult and failed in many cases.

Fisheries

Fisheries regulations related to mariculture include: prohibition of the introduction of specified species of fish (e.g. carp) without special permission from the Director of Fisheries; prohibition of the operation of fisheries at river mouths; regulation of product quality standards, which must be supported by a Product Quality Certificate issued by the Fisheries Division; and guidelines specific to individual, approved projects

National Environment Management Council (NEMC)

The NEMC was established under the National Environment Management Act (1983) to advise the government on all environmental matters. Its current commitments include the preparation of a National Conservation Strategy for Sustainable Development and guidelines for the requirement of an EIA by project developers. NEMC's legislative measures relevant to mariculture are: requiring an EIA for project approval, and requiring adherence to approved effluent standards

Land

Under existing land laws, there are no restrictions on access to land. Any person, citizen or foreigner can apply and be allocated land for any type of use. There is a statutory right of occupancy for allocated land that has a limit of 99 years and must be confirmed by a certificate of occupancy. The customary right of occupancy is supposed to be confirmed by certificate (*Hati ya Ardhi ya Mila*) and has no limit. In practice, however, it is a lengthy procedure to acquire land for mariculture, especially for a foreigner.

Water

Requests for water use rights are channeled through the district and regional water engineers, who after consultation with their committees forward the request to the relevant national ministry with a completed, detailed questionnaire. An approving national committee meets at scheduled times to consider applications. Once approved, a certificate of user rights is issued with no time limitations.

Needs

There is a need for oversight and accountability to make sure public policy, legislation and procedures are followed according to law. There are also some gaps in legislation for mariculture topics that should be addressed. Although local by-laws can be an effective tool in addressing specific issues, these need to be harmonized with national laws that pertain to mariculture.

Local Legislation

In some contexts, village governments may be more effective in local resource management and enforcement because they are knowledgeable of issues concerning their areas.

Coastal communities have their own assemblies where they pass resolutions on issues of concern including land allocation, curbing dynamite fishing, planting trees, setting restrictions on felling trees, and setting fees for various activities, schools, roads, etc. They may also set penalties for violations. But when necessary, important cases are generally taken to higher level courts. Although local by-laws may be more effective in particular areas and for particular issues than nationally enacted laws, they usually take a long time to pass and risk being overridden by the national laws.

Needs

Policies, regulations and guidelines that assist in alleviating the environmental, social and economic risks of mariculture need to be developed and implemented. This would be a helpful first step in moving towards increased investment and donor assistance for mariculture development.

3.3 *Management Tools and Methods*

3.3.1 *Mariculture guidelines*

To date, there are no specific mariculture guidelines for mariculture development, project approval, or operation.

Although there are no approved guidelines for mariculture, a number of investors submitted mariculture project proposals, some of which were approved and are ready for implementation. In the absence of general guidelines, the alternative was to formulate ad hoc procedures for each project with clauses involving other mariculture related sectors. The Fisheries Sector Policy Statements and Strategy provide for the establishment of mariculture guidelines. Development of mariculture guidelines would provide a framework for decisionmaking in the approval process.

3.3.2 *Enforcement capacity*

Enforcement capacity is weak due to limited resources and lack of awareness regarding the consequences of violating regulations related to environmental protection.

Weak law enforcement capacity will also affect mariculture development because theft and vandalism are common problems with mariculture worldwide. The Fisheries Division has a “Patrol Unit” that is established under the Surveillance and Enforcement sub-section of the Fisheries Legislation, Enforcement and Management Section (Figure 3.1). The major activity of the unit has been to fight dynamite fishing. Over the years, there were many arrests, but lack of evidence hampered the ability to apprehend violators. In some cases the patrol unit seeks assistance of the Unit of Marine Police. Cases were treated very lightly due to lack of awareness of the importance of damages caused by dynamite fishing and poor interpretation of the relevant laws, particularly where the prosecutors and judges are not conversant on fisheries and environmental issues.

Water quality guidelines and effluent standards are not enforced. There is an urgent need to build monitoring and enforcement capacity not only for mariculture, but also for the management of coastal resources in general.

Experience with enforcement of capture fishery regulations is poor. For example, although large-size beach seine nets (known as *juya la kojani*) were banned, enforcement authorities found it hard to eliminate the gear or even differentiate it from the ordinary seine nets used by the majority of fishers. More recently, all seine nets were banned, but the national fishnet industry still manufactures netting materials for the gear. The ban is ineffective because no practical alternative fishing method was given. Finally, enforcement capacity, which is usually low, cannot penetrate to the islands and isolated areas where the banned gear may be used.

Local militias are effective in enforcing civil law. These units were strengthened in the Tanga area to prevent illegal fishing. The same might be considered for enforcement of other types of environmental regulations. Also, once regulations governing operational aspects are established, improved enforcement capacity will be needed.

Needs

To increase enforcement capacity to detect and prosecute infringements of the law. This might be done by increasing resources to law enforcement agencies and by increasing their awareness of the rules and regulations governing mariculture. Existing forms of social capital such as local militias, and resource user groups such as fishers associations, may provide the basis for strengthening local-level enforcement capacity.

Additionally, strengthening the judicial system by increasing the awareness of the severity of the impacts of infringing on environmental protection laws may result in more substantial sentences and fines.

3.3.3 *Environmental impact assessment (EIA)*

The EIA is a key management tool typically used in the approval process for mariculture projects internationally.

In many countries, once the EIA is reviewed by the entity charged with granting approval, there are generally three possible outcomes:

- If the level of impacts is minimal, approval may be granted immediately
- If impacts that can be addressed with mitigation are found, then the project may be conditionally approved if mitigation measures are undertaken by the proposers
- If numerous and severe impacts are found which cannot be addressed through mitigation, then the project as proposed may be denied approval and the proposers must redesign the project

The EIA procedure as described above, is not fully utilized as a management tool in the country to date because of several constraints described below.

The EIA draft guidelines are not yet legally adopted.

EIA guidelines exist in draft form, but still need to be legally adopted. Legal recognition of the mandate for EIA procedures and official acceptance of the guidelines will strengthen the authority of NEMC in its role in the approval process.

EIA guidelines must be adapted to mariculture and missing elements must be put into place.

The EIA guidelines are progressive in that they include social factors, but specific points of consideration relevant to mariculture may be needed. While a number of environmental considerations are specified in the guidelines, many of the standards and criteria needed for the final assessment of impacts, are not established (e.g. water quality standards). The EIA guidelines also need to be expanded to consider environmental impacts on a larger scale (e.g. on the watershed or ecosystem).

EIA guidelines must be adapted to assess impacts of entire industries.

To date, EIA guidelines are project specific. There is currently no means of assessing the impact of a growing industry on the environment. EIA guidelines could eventually be used to set limits on the total number of operations, or scale of an industry, to cap the maximum allowable impacts in a given ecosystem.

EIAs are paid for and conducted by the business under study.

The current role of the government is to provide guidelines, suggest qualified consultants and approve or reject the EIA. The EIA is carried out under direction of the proposers, so the generally expected result is that few EIAs will be negative. Some system of quality assurance is needed for the EIA process, perhaps utilizing the oversight of a neutral party.

Since EIAs are conducted after land is obtained, their influence on the approval process is reduced, as implementation of a project is mainly dependent upon obtaining the land and business permits from TIC (see section 3.1.3).

As the approval process currently hinges on the matter of obtaining land for use in one of the three main use categories (industrial, agricultural or residential), and obtaining the financially necessary approvals from TIC, the EIA only serves to suggest mitigation measures, rather than acting as a basis for denial or approval of the project.

Although the current EIA guidelines specify that social factors must be considered, use of a participatory process is not required.

The affected community may not be included in preparation of the EIA and may only hear of the proposed project once the EIA is completed. The principal role of the public to date has been to react to finished EIA reports rather than being consulted in the preparation of the reports. Without specific opportunities for public consultation, the true social impacts cannot be fully assessed.

Needs

Monitoring systems for mariculture need to be developed and used in the approval and licensing process. Collection of baseline data before operations begin is the foundation of good monitoring programs. Environmental standards for water, soil and air quality, and related criteria are also needed. Local capacity to monitor adherence to environmental guidelines should be increased and linked to law enforcement activities.

EIAs are not currently linked to subsequent monitoring with the result that it remains unknown whether the predicted impacts occur or whether the recommended mitigation measures are effective.

Unless EIA and monitoring are linked under a comprehensive environmental protection scheme, assessment and reduction of impacts will be difficult.

3.3.4 Monitoring

The importance of monitoring as part of sustainable mariculture development has been recognized, but has not yet been acted upon. Monitoring as a management tool is usually used to detect and assess the level of environmental impacts. The results are used to guide or require improvements in the management of a business. They may also be helpful in improving the efficiency of operations since impacts on the environment may indicate certain inefficiencies in the operation.

There is no environmental monitoring system in use in the country.

Monitoring guidelines, methods and standards will be needed for sustainable development.

Implementing institutions also need to be designated and appropriate inter-institutional ties developed.

Monitoring should be carried out by a designated institution, but because the data will be required for use by a number of management institutions, planning and implementation of monitoring should be considered as an intersectoral issue and responsibility.

Baseline data collection and environmental standards are a key part of a monitoring program.

Assessment of monitoring results depends on the ability to make comparisons with baseline data collected before projects are put into operation, and for comparison with established environmental standards. Collection of baseline data should precede construction. Environmental standards should be specified and adopted as part of the monitoring program.

3.3.5 Zoning

Various types of zoning and land use planning are already in use in the country. These include: mangrove zoning as part of the management strategy of the mangrove management project; zoning used in national parks and reserves, and marine parks and reserves; and land use planning and zoning used in some urban areas. Three categories of land use (residential, agricultural and industrial) are specified when obtaining certificates of acquisition.

Certain marine areas, such as navigational routes, are excluded from other uses, yet after examining the various written policies governing land and water tenure, the MWG remained unclear on the question of how marine waters would be managed in the case of mariculture operations. Although this is not specifically mentioned in the written sectoral policies, there may be unwritten accommodations for this issue, of which the group is not aware. This issue requires further clarification.

However, not all land and water potentially subject to siting proposals for mariculture projects fall into these categories.

The danger is that inadvisable forms of mariculture could be proposed for this land not yet included in zoning schemes and because there are no legal obstacles to project development, an unsuitable project might be allowed. For example, land obtained originally under the intention of rice farming (agricultural) might be converted to prawn culture, which would fall under the same category.

In some cases, it may be possible to implement mariculture projects in a sustainable and appropriate manner in areas of restricted use or those zoned for other uses.

For example, it might be possible and beneficial to a local community to operate small seaweed farms in a marine park. Depending on how the area was designated, this activity might not be allowed although impacts may be non-existent or minimal.

The question of zoning and land use classification needs further detailed study in relation to mariculture and possibly other economic development activities.

Needs

Zoning of critical habitats should be developed or refined to determine where mariculture activities could be implemented sustainably.

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