

3 RESEARCH ACCOMPLISHMENTS AND FUTURE DIRECTIONS

3.1 Background

The Second EPMP strongly supported the intentions of WorldFish to rationalize and consolidate its nine programs into a smaller, more coherent set of interacting programs. In February 2000, the nine ICLARM Programs were consolidated into five and this was reflected in MTP 2003-2005:

- Biodiversity and Genetic Resources Research Program
- Freshwater Resources Research Program
- Coastal and Marine Resources Program
- Policy Research and Impact Assessment Program
- Partnerships, Information and Training Program, which was established as a cross-cutting support to all research programs.

In 2004, the research structure was further reorganized as a matrix of disciplines and portfolios (see Chapter 2). This Chapter will address the accomplishments under the old program structure and highlights of the new research structure will be presented under "Future Directions".

3.2 Research Accomplishments

3.2.1 *Biodiversity and Genetic Resources Research Program*

Introduction

In 2002, the 'Biodiversity and Genetic Resources Program' (BGRP) and the 'Germplasm Enhancement and Breeding Program' (GEBP) merged to form the 'Biodiversity and Genetic Resources Research Program' (BGRRP) which focused on inland waters.

In 2004, three operating projects (OP) were in progress within this program: "Conservation of aquatic diversity" (OP1, mainly FISHBASE, discussed in section b), "Mitigation of adverse impact of introduced species on aquatic diversity" (OP2) and "Genetic enhancement and breeding" (OP3). Activities in other aspects of freshwater aquaculture are considered in section c. Coastal aquaculture, including genetic aspects (characterization and management of stocks) is examined in section b.

From 1999 to 2005 the number of scientific staff devoted to these activities (excluding FISHBASE) ranged between three and six, of which two were mainly in charge of networking and training. It should be noted, however, that a large turnover (about 50%) occurred during this period.

Goals

The program's main goals are the characterization of genetic resources of freshwater fish for aquaculture and the testing of efficiency of different genetic improvement methods such as selective breeding, crossbreeding, experimental cytogenetics and interspecific hybridization, in order to define effective and efficient strategies for improvement of different species in general or specific contexts. A connected goal is to develop risk assessment and management tools for the introduction of genetically improved strains or alien species in new ecosystems.

The improvement of the growth rate in pond aquaculture has been a major objective of the program but only investigations on survival, cold resistance and production of monosex populations were performed. Tilapias, with a focus on Nile tilapia, and Asian cyprinids (about twenty species) were the main groups under investigation.

Activities

a) Tilapias

The “Genetic Improvement of Farmed Tilapia” (GIFT Program) was developed from 1988 to 1997 in The Philippines with the strong support of AKVAFORSK (a Norwegian ARI) and of two national research organizations. The GIFT program developed a strain with an increased growth rate that was subsequently transferred to different Asian countries (DEGITA program, 1994-1997). A gene bank of cryopreserved sperms representing the different populations initially collected (and several generations of selection) was created.

In 1998, continued selection in The Philippines was entrusted to the GIFT foundation, a private, non-profit organization. WorldFish activities were then reoriented towards the support of other national programs in Asia using the GIFT strain and continuing genetic improvement by various approaches (e.g. family selection, crossing with local strains, etc) and in transferring the 6th generation of the GIFT strain in Malaysia and to establish a control line and to examine the effect of different environments (ponds vs. cages) on the genetic progress. The latter is done in cooperation with the Malaysian Department of Fisheries.

Genetic improvement of Tilapias in Africa: Following the establishment of a WorldFish office and laboratory in Egypt, it was decided to develop genetic improvement programs in Africa based on the GIFT methodology but using local genetic resources. Three programs have been implemented: (i) in Egypt, efficiency of mass selection was investigated on two species (*Oreochromis niloticus* and *O. aureus*) and genetic parameters of growth and body shape were estimated; (ii) in Ghana, a synthetic strain regrouping four West Africa populations as a basis for selective breeding was established and the program is still in progress and, (iii) in Malawi, where Nile Tilapia is not indigenous, four populations of a local species (*O. shiranus*) were collected to create a synthetic strain that is under selection for growth rate.

Social and economic impact of GIFT in Asia: In collaboration with the PRIAP program (see section 3.2.4) data collected by the DEGITA program were analyzed in order to investigate in different farming conditions the magnitude of the genetic gain achieved and to assess the distribution of benefits between producers and consumers from the GIFT. In addition, adoption levels in several Asian countries and the returns to investment of GIFT technology there were estimated.

Alternative approaches for genetic improvement: A project for introducing and testing YY males for the production of monosex populations and homozygous clones for the production of F1 hybrid lines was implemented.

b) Carps (Asian cyprinids)

Supported by ADB (Asian Development Bank), the “Genetic Improvement of Carp Species in Asia” project was conducted from 1997 to 2000. In cooperation with NARS in

different countries, the focus of the project was an inventory of species used for aquaculture and, from the available data, characterization of genetic resources and of the results of different genetic improvement experiments (interspecific hybridization, strain crossing, polyploidisation, selective breeding). A Phase II component of this program was initiated in 2004.

c) Training and capacity building

Established in 1993, The International Network for Genetics in Aquaculture (INGA) aims at providing a forum for exchange of information, methods, germplasm and also for training and capacity building. INGA has now 13 developing countries and 12 developed countries members. During the period, activities were mainly dedicated to the management of the carp program, to the organization of expert consultation on biosafety and environmental impacts of introduced strains or species and to organization of training programs.

Outputs

The major outputs from this program are:

- Estimation of genetic parameters and response to selection for growth of tilapias in different contexts (ponds, cages) and for different methods (mass selection, combined selection). Heritabilities are in the range of 20 to 30% with similar values under high and low input conditions. Mass selection results in a 3 to 8% per generation progress, about half of what was obtained by a more sophisticated method (combined selection) in the GIFT program.
- Preliminary analysis of cold resistance for Nile tilapia in North Africa. No difference was observed between the random line and the line selected for growth. Heritability estimates for cold tolerance are very low and this problem, which is mainly limited to WANA area, should be solved by environmental management.
- Characterization of genetic resources of the black-chinned tilapia, a potential species for brackish water aquaculture. Genetically differentiated populations exist along the West African Coast, from Gabon to Senegal, with the larger within population variability in Ivory Coast, the middle of the distribution area.
- Assessment of the potential and implementation of gynogenesis and polyploidy for Nile tilapia (YY males, F1 crossbred clones, triploids). F1 crossbred clones appears hard to routinely produce. YY males are still in the experimental stage.
- On farm estimation of the performance of the GIFT strain in comparison with local Asiatic strains (DEGITA project): weight at harvest is higher both in ponds (from +11.4% in China to + 77.4% in Bangladesh) and cages (+16.7% in China, +19% in Philippines) and survival similar or better.
- Inventory of data on genetic resources for different carp species used for aquaculture in Asia: characterization of strains by various approaches, potential of interspecific hybridization, polyploidisation and gynogenesis, efficiency of crossbreeding and selective breeding in two species (silver barb and Rohu carp).

In close cooperation with the PRIAP program, two significant outputs were produced:

- Demonstration that GIFT is a “scale-neutral” technology: relatively similar progresses can be achieved for different levels of inputs.
- Development of a model for assessing the socio-economic impact of culturing GIFT in several Asian countries.

In terms of publications, 119 documents (among 613) are referenced in the WorldFish publication data base under the "AQ" discipline from 1999 to October 2005. Only 25 of these documents are related to genetic resources and genetic improvement, the others dealing with other aspects of aquaculture (pond management, socio-economic studies, nutrition and feeding, and related topics). The same proportion can be observed for publications in peer reviewed journals (10 out of 37). Conversely, some papers referenced to the PESS discipline are related to the impact assessment of genetic technology and can be considered as outputs of this program.

Outcomes

The most significant outcomes from this program (and its precedents) are:

- The development and implementation of national genetic improvement programs using GIFT material in Asia (Bangladesh, Fiji, Thailand, Vietnam, Malaysia) and the implementation of the GIFT methodology in Africa for local genetic resources (Egypt, Ghana, Malawi). INGA has played a key role for the coordination of these activities.
- The implementation of the GIFT Foundation in Philippines to support the continuation of selective breeding and dissemination of GIFT in this country.
- A high adoption rate by farmers: 2001 estimates indicate that adoption rate of GIFT or GIFT derived strains in 2001 was high in several Asian countries: from 30% in Indonesia to 70% in Philippines.
- An efficient training activity: several training sessions were organized during the period on themes related to selective breeding and production of monosex populations. Trainees from various Asian and African countries (about 20) attended these sessions (see Chapter 5). Original and high quality documents were produced by scientists. As a result, several qualified scientists are now in place in the main countries and are able to conceive and manage genetic improvement programs.

Impacts

Some of the major impacts from the work of this program include:

- GIFT impact assessment: In collaboration with PRIAP, the projected impact of GIFT based on five country-specific fish sector models (Bangladesh, China, Philippines, Thailand, Vietnam) has been estimated using observed parameters of the DEGITA experiment. The main results are: For an adoption rate of 30 to 40%, national production of tilapias should increase by about 13% on average with no negative impacts on the production of other species; market prices should decrease by about 9% and, consequently, per capita tilapia consumption should increase by 11% without adverse effects on the consumption of other species; profitability of fish farming for GIFT adopters will change according the share of tilapia in their production, e.g. from +6% in Bangladesh where tilapia relatively less important to 84% in Philippines where tilapia is the only freshwater farmed fish. On the other hand, due to the estimated price decline from increased production, non-adopters of GIFT will experience some reduced profitability.
- R&D economic efficiency: Using the GIFT impact assessment and the estimated total cost of the program (about US\$ 370M), the annual rate of return from GIFT research and dissemination investment was estimated at 70%.
- Environmental impact: A very preliminary and indirect assessment of environmental impacts of introduced tilapias was done through an enquiry among farmers of five Asian countries. According their declarations, tilapia introduction doesn't seem to cause displacement of existing fish species in natural waters in most of the countries.

In Philippines, where a minority of farmers claimed that the landings of existing species reduced substantially, a complementary enquiry was performed by a multidisciplinary team and concluded that “the decline of native species ... was probably the result of a number of factors, the least influential of these being the presence of exotic tilapia”. The Panel will comment later on this conclusion.

Assessments

a) Suggestions and Recommendations of external reviews

The program was submitted to three main external reviews during the period under review: a CCER review (2004) and two evaluations by donors, the European Commission for the “Genetic enhancement and breeding program” (2004) and the Asian Development Bank for the DEGITA program (2005).

The CCER recommended extension of the activities to new regions and species (while ensuring the capabilities of NARS or participating institutions to be long term and liable partners) to: stop the F1 clone technology approach; invest more in appropriate breeding methodologies (implementation of control lines, BLUP analysis), develop a more active publication policy in refereed journals, continue the “genetic improvement program of carp species” in Asia; and stimulate joint approaches with social sciences.

The major points of the EC review related to the IPG status of GIFT (In the case of partnership with private operators, “uninterrupted attention should be given to access by poor fisherfolk to improved GIFT stocks”), to the problem of biodiversity impacts (The Center should watch over the respect by every operators of Nairobi declaration in the case of import in Africa of genetically improved or alien species) and to a proper analysis of African specificities before implementing genetic improvement programs.

ADB emphasized several major lessons of the DEGITA program, among them the critical importance of “long term and sustained investments”, the need for an assessment of performances under various conditions before commercial production and the key role of partnership.

b) Panel’s Assessment

The Panel acknowledges the importance and the quality of results that represent a major contribution to the definition and implementation of efficient and sustainable genetic improvement programs for aquaculture species in developing countries. It recognizes the value of having tested the GIFT strain in various contexts and of having taken into consideration social and economic impacts of the technology. The fruitful cooperation with social sciences should be considered as exemplary.

The investments made in organizing and/or supporting national activities through an efficient network for information exchanges, training and capacity building (INGA) is another very positive aspect of the program.

The Panel believes the potential for the future of two other products of the program is very high:

- the database on the ten generations of selective breeding, which is unique in the area of fish genetics (except Norwegian data bases on salmonids), yet to be fully exploited (in terms of papers published) and should be considered and organized as a “virtual”

open laboratory for fish geneticists. Integration in FishBase could be an option for that.

- the sperms cryobank, which preserves wild genetic resources from Africa and could be used in the future for various purposes (restocking, estimation of long term effects of selection, estimation of impacts of climate changes or other human activities...). This cryobank is now maintained by a national organization in Philippines (BFAR) and remains accessible to WorldFish scientists but WorldFish should ensure that its IPG status is secured by appropriate agreements.

Concerning carps aquaculture in Asia, the Panel emphasizes the quality and importance of activities coordinated by the Center for collecting useful data for the definition of genetic improvement programs on these species.

The Panel endorses the main conclusions and recommendations previously presented. In addition, with regards to the plausible large dissemination of GIFT methodology and/or products, the Panel considers that several points deserve special attention:

- **The weakness in publications in peer reviewed journals.** In the case of the GIFT program, only the results of the first phase (the comparison of strains and their crossbreds) have been published and no paper is available on the estimate of genetic progress during the first five generation. A significant effort must be made in this area and the Panel was informed that such an effort has actually started in 2005.
- **The still imprecise estimation of the genetic progress.** Due to the lack of a control line derived from the same gene pool, the magnitude of global genetic progress, often claimed to be 80%, remains imprecise. Progress Reports of the GIFT program give only comparisons between each generation and the former and/or comparisons with some Asian strains tested at the beginning of the program (Israel, Thailand). The DEGITA program estimated the superiority of GIFT strain over various local strains in farming conditions but these strains are supposed to have poor performances (that's why wild African populations were introduced at the beginning of the program). Therefore, the Panel strongly concurs with the creation of a control line for the continuation of selection in Malaysia even if some "relaxing effects" are likely to occur in this line that could lead to overestimate further genetic progress.
- **The dissemination of the "GIFT technology package".** This package is in fact regrouping several innovations: (i) the replacement of a local strain by a new synthetic gene pool resulting from the introduction, testing and crossbreeding of several wild or domestic populations; (ii) a proper management of this gene pool in order to avoid inbreeding and to allow progressive adaptation to local farming conditions through natural selection; (iii) a selective breeding methods that could be based only on individual performances or integrate family performances and (iv) sometimes, the technology for producing mono-sex populations. Considering that each of these tools has a specific interest and cost/benefit balance in the different aquaculture contexts and can be use independently, the Panel suggests that the WorldFish dissemination and capacity building policy should adopt a stepwise approach and more effectively distinguish between these tools.
- **The limited knowledge of the biological components of response to selection, especially changes in feeding behavior and food conversion efficiency** (higher spontaneous feeding rate and/or better food conversion efficiency). The assumption that GIFT allows more fish to be produced for the same amount of feed and/or fertilizers inputs, i.e. has a better growth and a better feed efficiency, is not obvious with regard to the scientific literature. Data on these points are only global estimates

in farming conditions without direct measurement of ingested food and using comparison with local Asian strains. Although they have concluded that a dramatic improvement in protein utilization in the GIFT strain has occurred, this result is difficult to impute only to selective breeding. This issue can be considered as a minor point for situations where tropic resources are in excess. It can become more serious in the case of intensive aquaculture or at the opposite end of the spectrum, i.e. in the case of very low input aquaculture systems or in polyculture systems.

To better understand the way selective breeding changes biological growth parameters, the Panel recommends further studies on GIFT be undertaken by geneticists and nutritionists working together, using more controlled experimental conditions, and testing a large range of feeding levels.

- **The assessment of the socioeconomic impact of GIFT.** The projected impact assessment presented to the Panel seems to be promising but is based on imprecise biological parameters (see former remark) and economic modelling. In order to reinforce these results, the Panel encourages WorldFish to undertake *ex-post* empirical studies in countries where large changes are believed to have resulted, e.g. the Philippines.
- **The assessment of environmental impacts.** The 2nd EPMR commended the Center for “undertaking environmental risk assessment associated with genetic improvement on fish”. The EU review made a similar remark. A very sensitive point is the impact of introduced tilapia, for which evidence of interactions with native species exists in the scientific literature. The preliminary results based on farmer’s declarations can not be considered as a reliable and convincing argument for the lack of environmental impacts. The Panel acknowledges the methodological difficulties that exist to obtain accurate data in this area but encourages WorldFish to seriously consider this issue.

3.2.2 *Freshwater Resources Research Program*

Introduction

The Program has a long history within the Center. It is built from a series of activities aimed at increasing the productivity, sustainability and profitability of freshwater aquaculture, and improving management of lakes, reservoirs, small water bodies, rivers and flood plains. Since the last EPMR, 25 projects - with a total budget of approximately US\$ 14.6M - have been executed, including: Integrated Agriculture - Aquaculture (IAA), Development of Sustainable Aquaculture (DSAP), Pond dynamics, and a number of Community-based projects on: Fish Culture in Flooded Rice Fields, fisheries management in flood plains and rivers, and Management of Aquatic Biodiversity and Fisheries.

An average of four Scientists per year has been involved in the program since 1999. Based on a review of human needs and the biophysical potential for positive gains from research, the focus during the current review period was on Africa, East and South-east Asia, in arid, semi-arid and humid environments.

Goals

The Program seeks to improve the livelihoods of fishers and fish-farmers of freshwater living aquatic resources. There are two main thrusts aimed at 1) increasing the

productivity and sustainability of freshwater aquaculture within the context of African and Asian farming systems; and 2) improving the knowledge base and management of freshwater living aquatic resources within the context of changing watersheds. The principal cultured species, including the GIFT tilapia, cyprinids and *O. shiranus*, are examined in section 3a.

Activities

The overall strategy for realizing the goal of sustainably improved management of freshwater resources is based on extensive analysis and pragmatic problem-solving. The projects are executed using networks and partners as tools for transferring technology and disseminating and exchanging information among farmers and small-scale fishers, collaborating scientists, individuals and government counterparts. The projects targeted the whole family and, using a participatory extension approach with a significant participation of women and girls, reinforced farmers, government officials and NGO partners with human capacity building.. During the present review period, the focus was on refining, validating, scaling-up and scaling-out the IAA and sustainable aquaculture technologies through research-extension-farmer partnerships, thus combining poverty with a fish focus. The methodologies and technologies for some aspects of the research for example for IAA and for sustainable aquaculture development had been developed even before the Second EPMR.

Outputs and Outcomes

Work on nutrient use efficiency based on station and on-farm experiments and modelling in Malawi demonstrated the usefulness of undertaking further work to improve the resilience to drought by planning and managing resource flows through IAA. Over the past seven years, the IAA technology has been adopted by over 200,000 new farm families. It is also expanding to Cameroon, Zambia and Mozambique. Commercial aquaculture opportunities have been created in Malawi and have potential to contribute to meeting the target production of 5,000 tons per year.

Methodologies and technologies for promoting pond and rice field based aquaculture and the efficient use of wetlands were elaborated and validated. As a follow up to these initiatives, emphasis was placed on techniques for scaling-up the initiatives through community-based partnerships and the gradual infusion of new business practices into rural areas. Raising fish in rice fields in Bangladesh increased the productivity and efficiency of farms and profitability was increased up some 20-85 per cent. The approach and technology has been successfully tested under an “adaptive learning” process in India on farmers managed trials. The Central Inland Fisheries Research Institute in Barrackpore provided technical assistance while WorldFish’s role was that of enabling, coordinating and managing funds provided by DFID for this initiative.

The production of a decision-making tool (Bayfish) utilizing data on species and habitat diversity and the development of modelling approaches linking fish production and hydrological patterns in the Greater Mekong Region are important additional outputs of the project. Policy and decision-makers have become aware of the value of aquatic resources to food security, livelihoods, and national economic development in the Greater Mekong Region. An integrated planning process has been launched in southern Laos and Vietnam to measure trade-offs between mangroves and expanding shrimp aquaculture. Other relevant outputs of the Greater Mekong project have been: (i) training

of scientists, professional staff and students at IFReDI, the Mekong River Commission and IUCN in Bayesian modelling, fisheries biology, research methods, data analysis and report writing; and (ii) more than 20 publications in the form of technical reports, country and regional profiles, guidelines on stakeholder consultation, co-management and conflict management and BayFish Model use. Moreover, 32 peer reviewed publications of the Program's work, 29 non-refereed papers and five proceedings of international conferences and seminars have been published. Many of these outputs will lead to IPGs in the form of, among others, guidelines, decision-making tools and manuals (e.g. the policy brief on conflict management and policy guidelines for management of excess fishing capacity in small-scale fisheries).

The DSAP has spread new business, marketing and technological knowledge to the Bangladeshi population. Current emphasis/focus is on leveraging partnerships and skills to initiate market-driven aquaculture for the poor broadly. Scaling-up of the sustainable aquaculture technology has occurred and at least four community-based fisheries management projects funded by a variety of donors are being implemented independently by the government of Bangladesh. Community-based fisheries management approaches are also being implemented in Vietnam.

Thanks to innovative approaches developed under the community-based fisheries management projects, fishers in Bangladesh have gained access over the last four years to more than 115 water bodies covering close to 17,000 hectares thus increasing fish production and improving livelihoods for poor communities. In addition, 164 fish sanctuaries have been established in 81 water bodies covering 91 hectares.

Thirty-four training courses (19 national and 15 regional) involving a total of 502 trainees from 71 countries with a total of 3,484 trainee days were organized within the framework of the program (see Chapter 5).

Impacts

Impact assessments of the outputs of this Program both in Bangladesh and Malawi are reviewed in section 3d. In the areas of Malawi where IAA technology was adopted productivity of farm ponds improved substantially with the average yield more than doubling, from 1.34 to 2.73 t/ha. It has also been instrumental in increasing income (three to four times in some cases). Fish consumption in the project areas rose by about 160 percent and childhood malnutrition fell by 15 percent. The IAA technology has led to fish constituting an increased share of incomes in farming systems from some five percent before projects to more than 35 percent after. Geographical expansion of the IAA technology is creating conditions for spin-offs and contributes towards macroeconomic growth, job security, exports, and food security for the country's increasingly urban population. The IAA technology has been adopted as the official production technique by the Government of Malawi.

The integration and upgrading of hatchery, nursery, feeding, marketing and other components of the value chain resulting from the development of sustainable aquaculture in Bangladesh have contributed to raising production and total household income from fish culture (improved technologies) from 15 to 26 percent. The total number of households involved was 70,000. At the same time the proportion of total household income from fish increased from 5 percent before DSAP to 36 percent.

Panel's Assessment

The goals of this Program are fundamental to achieving the Mission and aims of both the Center and the CGIAR (CG). In addition, the projects carried out under this Program are in line with the CGIAR system's priorities, in particular: integrated land, water and forest management at the landscape level, sustaining and managing aquatic ecosystems for food and livelihoods and improving water productivity. They all seek pro-poor solutions.

The Panel noted that no specific CCERs had been undertaken on the FRRP. In its assessment of the Program, the Panel was able to draw on the Mid-Term Report of the DSAP, an assessment of progress under the DSAP by USAID and two CCERs on the Regional Strategies for Sub-Saharan Africa (SSA) and East and Southeast Asia (ESEA), which have a bearing on aspects of the program. All the reviews indicated that FRRP work was highly productive, the methodologies and technologies developed were sound and the results fulfilled the needs of WorldFish clients. The Panel concurs with the general findings of these reports. Two recommendations were of particular interest to the Panel: (1) that WorldFish should give special attention to improving the quality of institutional partnerships (CCER for ESEA); and (2) that WorldFish needs to ensure that it remains within its CG-defined remit, focusing on 1) generating new knowledge or ways to use old knowledge in new ways, 2) facilitating the dissemination, uptake and use of that knowledge, and 3) building capacity in research and facilitating knowledge uptake (CCER for SSA). The practical application of that knowledge for development purposes, and the associated skills, should be left to partners who have the comparative advantage in those areas. The Panel invites the Center to give due attention to these recommendations.

In the Panel's view, the initiatives under this Program represent state-of-the-art approaches in very innovative forms that are contributing substantially to achieving the WorldFish mission, goals and objectives. The significant outputs and impacts of the technologies are due to several factors including the whole family-participatory approach, linking with appropriate NGOs in implementing many projects within the Program, and, in particular, the involvement of women and girls. The latter were actively engaged in feed preparation, gear mending, collection of fish for consumption, and also had a greater role in decision-making. Forty percent of the participants in the IAA project in Malawi were women. In Bangladesh, 22 percent of the farmers who received grants from participating NGOs were women, while for receivers of grants from non-participating NGOs, the figure ranged from 6 to 16 percent.

The impressive outputs of the Program are due to successful partnerships with several NGOs in Bangladesh and World Vision in Malawi who are very good in mobilizing populations and possess strong rural extension qualities. In addition, in the case of DSAP in Bangladesh the NGOs were skilled in the management of credit among rural communities. Mindful of WorldFish's plan to scale-up the IAA methodology and technologies in SSA, the Panel encourages WorldFish to consider working in collaboration with the Consortium of World Vision national structures in Sub-Saharan Africa to attain its objective. The Panel was informed that a MoU governing Africa-wide collaboration with World Vision International will be signed during the week starting 13 February, 2006. The overall output generated at a number of such sites is likely to be more robust for extrapolation. In addition, such cross country links between outputs would contribute to their transformation into IPGs.

Research on IAA and rice-fish culture are examples of projects where there could have been stronger interaction between WorldFish – a specialized and thematic Center- and other appropriate CG Centers such as IITA, IWMI and CIFOR. The Panel encourages WorldFish, if and when possible, to collaborate with other appropriate Centers of the CG under its “Fast Track Opportunities” in SSA in the framework of NEPAD, to scale-up successful IAA technologies from Malawi to other countries in Southern Africa. The Center may also wish to consider creating research programs in the commonly accepted priority areas which might add value to international efforts in improving livelihoods in poor farming and fishing communities.

The outcomes of the biodiversity and fisheries management research in the Greater Mekong Basin (judged as being of high quality by an EU commissioned report) are good and the global importance of the outputs is potentially high with wide applications in the watersheds and flood plains in ESEA, SSA as well as South America. Efficiency has been greatly enhanced by the degree of scientific collaboration and partnership pursued within the GMR and interaction with IWMI and scientists from outside the area for example, South Africa, Australia, UK, Sri Lanka, Brazil, and Finland. The Panel encourages WorldFish to explore the possibilities of interacting with scientists involved in similar activities in these regions and, as appropriate, consider the transfer of methodologies and technologies to other eco-regions taking into account their specific conditions. It was reported that habitat restoration activities and sanctuaries in Bangladesh have led to increases in biodiversity, in some areas by as much as 30 percent. The Panel considers this an important finding and invites the Center to endorse this information with more studies.

The Panel found ample evidence in the documentation provided and in the relevant publications, as well as during its interaction with WorldFish partners that WorldFish methodologies and technologies in IAA, flood plains and rice-fish culture as well as wetlands/river basin fisheries are generally of good quality and relevant for the recipient countries. The Center has received client recognition and support for its delivery of practical, validated technology (See Chapter 4) even at the village level.

The adoption of the whole family – participatory approach together with the limited number of staff allocated to the Program favored the involvement of a wide variety of partner-groups in project implementation and of the Center in the entire Research-to-Development Continuum. For example, training in natural spawning techniques could be given to a particular partner-group that could then scale-up the activity. The Panel, however, ascertained from documentation that such training is often given to a wide variety of partner-groups: government officials, NGOs and contact farmers and includes the provision of extension services. While these activities in some instances are justifiable in as much as they can and do contribute to outputs, the wide variety of partner-groups targeted and the degree and intensity of such activities tend to detract staff time from science and usually carry high transaction costs. The Center should explore ways to devolve such down stream activities to other development oriented partners.

The Panel’s opinion is that over the past seven years the FRRP has produced relevant outputs with clear impacts. The Panel is however convinced that the outputs could be made more relevant and long term impacts on the development agenda substantially enhanced if the Center optimally positioned itself in the Research for Development Value chain, a phenomenon that the Center acknowledges in its new strategy. Fundamental to

achieving this, the Panel considers it essential that WorldFish should work to better understand the weaknesses and strengths of its partners.

The Panel noted that much of the work undertaken had not been packaged in forms appropriate for use by WorldFish partners to scale out methodologies and technologies. Without the adequate capture, interpretation and translation of this knowledge into specific and relevant forms of communication (such as publications in refereed journals, manuals and technical briefs for use by partners and NGOs), much of the value of the good aquatic science that is currently being produced at some sites will not benefit several poor riverine or coastal communities.

In order to ensure that its development oriented partners are better equipped to scale out methodologies and technologies for enhancing outcomes and impacts, the Panel recommends that WorldFish:

- *continue to make a conscious effort to move away from downstream development activities and explore opportunities for development-related activities to be executed by local or bilateral entities, where available, while the Center continues to monitor and evaluate the activities/developments in order to analyze the impacts and also to identify constraints and bottlenecks which might require further research;*
- *undertake a scoping exercise to identify its partners' strengths and weaknesses in order to better target capacity building, especially of NGOs, to advance the development spectrum of its work; and,*
- *synthesize and package existing information, including frameworks, manuals, protocols and guidelines to ensure greater dissemination and use of its products.*

The spectacular achievements of the IAA and other technologies in Bangladesh where WorldFish has a history of over 30 years and in Malawi (close to 20 years), demonstrate that long term commitment is essential for success. The Panel suggests that WorldFish should continue to pay particular attention to the long term viability of its program in selecting strategic focal countries, particularly in SSA, in order to be able to maintain durable operational structures from which IPGs could be developed.

IAA and the rice-fish systems are more dynamic, durable and resilient sources of livelihoods than traditional farms. This is demonstrated by the fact that IAA farms are 18 percent more productive during drought than traditional forms of farming. This has great implications particularly in Southern Africa where with almost four farmers per hectare, even mild droughts can lead to food shortages. The IAA and rice-fish systems however have potential for conflicts with regard to water use and management. In this context, the Panel commends the Center for the excellent collaborative work with IWMI in the Mekong Region and invites further strengthening of such interaction to address issues related to water management.

Future Directions: In the new program structure the activities of FRRP would be realigned to either NRM or AGI. The future directions of the Center under this new framework are discussed in Chapter 3(II).

3.2.3 Coastal and Marine Resources Program

This program was reformulated in the 2003-2005 Mid Term Plan and in accordance with the priorities of the then Strategic Plan, focused on coral reefs and other near shore coastal habitats, by targeting populations of poor coastal communities in Southeast Asia

and Small Island Developing States, primarily in the Pacific. Very large numbers of people live in or near the coasts of these regions and are dependent on their highly productive ecosystems for food and livelihoods. Despite this however, near shore habitats such as coral reefs, mangroves and seagrass beds, together with large areas of the shallow continental shelf, are among the most threatened or degraded on the planet. An average of 12 scientists has been involved in the program since 1999. The project portfolio of CMRRP was subsumed into the larger Natural Resource Management (NRM) discipline area of the new management structure in 2005.

Goals and Activities

a) Goals

The Coastal and Marine Resources Research Program sought to equip developing countries with the means to increase the productivity of inshore fisheries resources on a sustainable basis. In particular, the program endeavored to assist managers: to rebuild stocks to more productive levels; to increase the productivity of fisheries resources and the opportunities for alternative livelihoods through the application of aquaculture; and to reverse the degradation of the habitats that support fisheries.

The program focuses on inshore fisheries, particularly those associated with coral reefs and shallow soft sediments in Asia, Southeast Asia and the Pacific. This focus was clearly relevant to the previous and current WorldFish mandates to reduce poverty and hunger by improving the livelihoods of fishers. The major problems faced are increasing human populations, decreasing fish stocks, degraded habitats, loss of livelihoods and the prospect of higher prices for fish. Hence the development needs relate to provision of more fish to meet increasing demand, improving the environment, more livelihood options, and information for decision making. Research activities of the program therefore had three major goals: 1) Restoration of Capture Fisheries; (2) Promoting Environmentally-Friendly Coastal Aquaculture; and (3) Reversing Degradation of Coastal Habitats. In addition, databases have been a central aspect of the Program's efforts.

b) Activities

i) Restoration of Capture Fisheries

From its inception as ICLARM, WorldFish became a world leader in tropical fish stock assessment. The use of statistical and modelling techniques (Elefan etc) established collaboration and capacity in this area in many developing countries. These successes were followed by the development of ecosystem modelling techniques (Ecopath etc), but loss of staff and other changes led to a decline in WorldFish involvement in this type of modelling. However, with particular reference to the massive declines in trawl fish catches in SE Asia, the need in terms of development assistance really switched to sustainable management and restoration. WorldFish responded with the development of TrawlBase in collaboration with UBC and eight SE Asian countries.

ii) Promoting Environmentally-Friendly Coastal Aquaculture

This program concentrated on inshore species with a high market value and low environmental impact that are amenable to small-scale culture in shallow coastal waters. The Coastal Aquaculture Center set up by WorldFish in the Solomon Islands developed the aquaculture of giant clams, pearl oysters and sea cucumbers prior to its

closure in 1998 due to civil unrest. Despite this setback in the Solomon Islands, the Center was re-established in New Caledonia in collaboration with IFREMER and successfully piloted sea cucumber and pearl culture, with significant potential for extension within and outside the region. In particular, the project for “Development of New Artisanal Fisheries Based on the Capture and Culture of Postlarval Coral Reef “Fish” not only has a simple design, but broad potential for uptake by coastal communities who could substantially increase their income from the sale of these fish.

iii) Reversing Degradation of Coastal Habitats

Two-thirds of all coral reef areas are found in developing countries and border much of the coastline of some of the poorest countries in the world. Almost 500 million people live within 100 km of a coral reef, but the number of people depending on coral reefs and their level of dependence are not well understood. Tens of millions rely on reefs to support part of their livelihood, providing food, income and basic subsistence needs. Despite numerous research and management projects on coral reefs, there has been little coordination and data sharing. This and the lack of data management capacity in developing countries led WorldFish to start ReefBase in 1993 in order to synthesize data on coral reefs in a standardized database in support of research and management.

iv) Databases

WorldFish is responsible for three major database initiatives: FishBase, ReefBase and TrawlBase. While the latter two are dealt with under research activities above, FishBase, as the world’s premier source of information on all fish species, stands alone.

FishBase comprises the accumulation and structuring of knowledge on fish biology and ecology over the more than 15 years since its inception. It now contains over 28,000 species of fish known to science, has over 80,000 synonyms and 200,000 common names in over 250 languages. The names are the key to accessing knowledge accumulated over time and mobilizing scientific and non-scientific knowledge systems. Over 25,000 pictures illustrate these fish and information about them has been extracted from 20,000 references. The development of ‘Key Facts’ by species, first implemented on the web-version to great effect in late 1998, allows rapid estimation of key indicators of relevance for managers and conservationists. Estimates of these life-history indicators with ‘best estimates with error margin’ can now be produced rapidly on the basis of information already inside FishBase and re-estimated with the user’s own data, as required. As an additional complement, an October 2000 update of IUCN’s list of threatened fishes is incorporated. FAO nominal catches from 1950 to 1998 and the further improved presentation and analysis of tropic ecology information available to all interested users opens the doors for new types of global trend analysis.

The breadth and depth of information achieved so far, allows for new questions. This, in turn, allows shaping more analytical routines or other outputs with the potential for making the database more useful to scientific users. The constantly growing emphasis on graphical presentations of data, the relationships between different data sets, as well as the derivation of synthetic indicators like the ones mentioned above, make it increasingly interesting to a wider audience. It is hoped that the various tools will encourage local applications of global knowledge through interfacing with national data sets.

WorldFish no longer controls FishBase, but manages it as part of a consortium of museums, fisheries research institutes and international organizations with a fisheries mandate. The consortium has made an open-ended institutional commitment to further develop and consolidate FishBase and keep it in the public domain. The founding members of this open consortium are: Swedish Museum of Natural History (Stockholm), Royal Museum for Central Africa (Tervuren), Muséum National d'Histoire Naturelle (Paris), Institute of Marine Research (Kiel), Fisheries Center of the University of British Columbia (Vancouver), FAO (Rome) and WorldFish (Los Baños). The consortium members will thus ensure that the shared knowledge platform for the more than 500 individual and institutional collaborators and for the innumerable users around the world will continue to thrive.

Outputs and outcomes

WorldFish has developed innovative restocking and alternative livelihood options for sea cucumber (beche de mer) fisheries. It may be possible to use these options to help with the recovery or sustainable management of the fisheries in Vietnam, Philippines, Indonesia, PNG, Solomon Islands, New Caledonia and Kiribati. Transfer of pearl growing technology from Polynesia to Solomon Islands has created a potentially significant source of income for local people. However, WorldFish is re-focusing the biological work on the technical aspects of culture and restocking to a more comprehensive approach in which culture and restocking are seen as one management tool among many for small scale fisheries (SSF). The Panel sees this evolution as an important step in the application of some very important biological results to improved management and livelihoods in SSF (see Chapter 3 (2)ii) and endorses the approach. In the absence of this reorientation of focus, the biological work on culture and restocking could not achieve any management outcomes.

FiRST software and the regional database TrawlBase have, through workshops with eight different countries, been used to identify problems and the need for action in SE Asian fisheries where stocks have been reduced to more than 30% of levels prior to fishing. The results of the workshops have been published and made available to management agencies. This database system brings together very valuable data sets generated from national trawl surveys and again, uses excellent scientific principles to help standardize and analyze very important time-series data. The Panel notes that the outputs of TrawlBase currently provide the only scientific data of the type essential for planning sustainable trawl fisheries management. To date, only the Malaysian Government is implementing the recommendations of the TrawlBase workshop report in relation to establishment and maintenance of adequate catch databases, but there is scope for the transfer of the TrawlBase concept and technology to other areas of the world.

FishBase is the world's leading on-line information database on fish, and as such, hosts the databases of members from more than 100 countries and more than 1200 collaborators. Its use is extraordinary (23 million internet hits per month) and it is the first port of call for queries about any particular fish from fisheries managers and scientists throughout the world – both in developing and developed countries. FishBase is considered the best documented and most comprehensive of all biodiversity databases. It has become a tool that most fisheries staff cannot do without. Despite the richness of their aquatic resources, many African, Caribbean and Pacific (ACP) countries are among the least developed. Hence, the need for the creation of an enabling environment for ACP science and research was recognized during the dialogue on the Fisheries Research Initiative demanded by the ACP-EU Joint Assembly (a parliamentary body composed of

ACP representatives and members of the European Parliament). One of the resulting projects, entitled 'Strengthening fisheries and biodiversity management in ACP countries', uses FishBase and its analytical capabilities as its technical backbone.

ReefBase is rapidly becoming the FishBase equivalent for all those researching or managing coral reefs with 7.3 million 'hits', and 259,000 publication downloads by 770,000 users in 2003. It is being used by research institutions, governments and NGOs to improve coral reef management and hence benefit the poor who depend upon sustainable management of reef fisheries resources. The Panel notes that it is now widely recognized as the world's main information system on coral reefs. The new web-based ReefBase is dynamic, updatable, more user-friendly and client oriented, and able to house or access virtually unlimited amounts of information. The recently added GIS and mapping functions significantly increase its power and usefulness, e.g. to managers of marine protected areas, in helping to visualize threats or other factors which may influence the effectiveness of management, or coral reef hotspots where donors may wish to concentrate resources; and to NGOs who may wish to advocate on behalf of coral reefs, scientists and the interested public. Due to a change in strategy in 2000/2001, ReefBase now focuses less on raw data and more on information summaries. It was of great value recently in the compilation and mapping of data on the effects of the December 2004 Tsunami on coral reefs and fisheries of a number of nations, notably Indonesia, Maldives and Seychelles, thus allowing suitably targeted research and management responses by several countries including UK, Australia and USA.

With regard to scientific publications, unfortunately of the approximately 70 refereed publications produced by this program since 1999, only about 30 were in international journals with a measurable impact factor (see Chapter 4 for a more in-depth analysis). The remainder are in local or regional journals or conference proceedings of questionable quality. By any yardstick this performance is below the norm for a research institution, especially given its new vision statement "to be the science partner of choice for delivering fisheries and aquaculture solutions for developing countries". The Panel urges the Center to increase both the quality and quantity of its scientific publications.

Impacts

While direct impacts on poverty alleviation have not been realized or documented, the Panel is satisfied that there is ample evidence that this program has produced results that have had intermediate impacts. Of particular note are tools such as ReefBase and FishBase, which have been used in research projects that have produced results that have influenced fisheries management policy.

Panel's Assessment

a) FishBase

FishBase is the achievement for which WorldFish is best known and world famous, but it is also of primary importance for the planning and execution of WorldFish research as well as of other research institutions and organizations. However, as the recent (November 2005) EC "Review of the WorldFish Center Project 1, Conservation of Aquatic Biodiversity" report states: "The degree to which the needs of these diverse groups are met is perhaps the measure of the relevance and success of the 'project' ". There is a risk that FishBase is driven by the interests and expertise of the consortium, rather than by an assessment of real needs. In particular, there are important differences between the

consortium's focus on global biodiversity and WorldFish interest in regional research and management capacity for biodiversity conservation to alleviate poverty. Notwithstanding the above, there is no doubt that WorldFish obtains added value and derives great benefit from FishBase – not only was it 'fathered' by WorldFish, but the 'brand name' places a kudos on WorldFish that should not be underestimated in terms of influence.

While acknowledging the key role of FishBase within the newly defined NRM priorities and strategic directions, the Panel recommends that WorldFish clearly define its continuing involvement and role in the database, including specifying how the various demands on staff will be met.

The Panel also notes that FishBase offers a powerful tool for communicating and promoting new tools for small scale fisheries management.

External Reviews and Commentaries

a) CCER

This significant review, carried out in November 2003, was largely favorable, particularly with regard to relevance to WorldFish's mandate, its priorities, quality of research, scientific output, thrust directions, and identification of impact pathways. Nevertheless, it contained a list of 17 recommendations concerning aspects of the program in need of improvement. These recommendations were recognized by the Center and were used to assist with the organizational transformation that began after the appointment of the new DG. Restructuring according to the new discipline/portfolio matrix management has dealt with many of the structural issue recommendations such as impact pathway analysis, consolidating programs to maximize critical mass in key areas, strengthening cross-program linkages, streamlining project management, strengthening ties across WorldFish outreach sites, making use of adjunct scientists, and greater integration across projects within WorldFish. However, the Panel believes that the recommendations concerning maintaining high-end science reputation, the production of landmark papers and reviews and publishing in prestigious journals, require further attention if they are to be achieved (see also Chapter 4).

Recommendations from the CCER indicated that the Center should consider placing greater emphasis on landmark publications and reviews. In this context, the new review "Restocking and stock enhancement of marine invertebrate species", published in *Advances in Marine Biology* in December 2005, is particularly commendable. This publication in a prestigious book series, is highly relevant to the many restocking issues around the world, and will undoubtedly become a major reference of choice for managers and research scientists dealing with this topic.

3.2.4 Policy Research and Impact Assessment Program

Introduction

The Program was set up in 1996. Its original portfolio was developed from socio-economic and bio-economic studies associated with the Center's biotechnical research in support of fish farming and fisheries management in developing countries. Since 1999, PRIAP conducted its research and capacity building efforts under three main thematic areas: (i) Economic and social analysis and valuation of aquatic resources in developing countries, (ii) Aquatic resources planning and impact assessment, and (iii) Legal and

institutional analysis for fisheries management.. Since the last EPMR, the program has conducted projects in East and Southeast Asia, South Asia, the Pacific, Sub-Saharan Africa and the Caribbean. In 2005, as part of the Center's reformulation of its operational and research log-frame, the Program was renamed "Policy, Economics and Social Sciences, (PESS)".

Information available on scientist staff for PRIAP shows total of 12 scientists between 1999-2002. This situation improved between 2003 and 2005 when the total number of scientists resident in PRIAP reached a total of 18 of which eight were Ph.D. internationally recruited, four regionally recruited (2 Ph.D. and 2 MSc.) and five nationally recruited (1 Ph.D. and the rest MSc., MA, BSc. and BA.).

Goals

The main objective of the Program is to examine policies and options in fisheries, aquaculture and coastal and freshwater resources management to ensure the wider adoption and benefits of research by the poor in the developing world. WorldFish indicates that the Program embraces three broad goals: (i) to examine policy environments and policy options for adoption of approaches, technologies and policies to benefit the poor; (ii) to provide information and tools to fishers, researchers, extension workers and policy makers in making decisions on appropriate institutions for managing aquatic resources; and (iii) to assess the impact of aquatic research and development.

Activities

The Program has conducted its activities in four different modes: first, drawing information and knowledge from other Program research projects to document their economic and social impacts, such as with IAA in SSA and Asia; second, conducting field research in a participative manner, training and networking with national partners and communities to gain knowledge about factors and conditions determining resource users behavior and promote improvements in policy, institutional and management arrangements; third, drawing and synthesizing information and knowledge on model fisheries and aquaculture supply and demand to forecast its development alternatives at the global, regional and national levels; fourth, identifying and applying valuation tools and methods on coral reefs and wetlands to provide information and knowledge to support the design of policy setting management priorities for sustainable use.

A total of 38 projects were actively conducted by the Program during the period 1999-2005, including: research, capacity building, dissemination and/or networking. The Program shows a steady annual increase of 27% in the number of projects conducted, ranging from 6 projects in 1999 to a maximum of 22 in 2005.

Overall, these projects covered one or more of the following topics:

- i) Determination of world supply and demand for capture fisheries and aquaculture and its analysis for forecasting and global, regional and national policy design
- ii) Market analysis for fisheries and aquaculture products
- iii) Economic valuation of aquatic environments and resources including Coral Reefs
- iv) Socioeconomic and bio-economic analysis of coastal fish stocks
- v) Project and research impact assessment

- vi) Co-management approaches and gender participation in coastal and inland fisheries management
- vii) Community assessment, management and monitoring of local aquatic resources
- viii) Analysis of legal and institutional frameworks for coastal and inland fisheries management and development.

Outputs

In addition to publications and training, this Program generates three main types of outputs: (i) frameworks and guidelines, (ii) methods and (iii) models and analyses.

a) Frameworks, guidelines and methods

A framework was developed to encompass an impact pathway analysis for research planning and priority setting and was discussed during the 2002 and 2003 Science Weeks. The approach adopted is that of “ex-ante” impact assessment based on the three types of research that the Center delivers (i.e. research on technology, research on natural resources management and policy research). Impacts are classified as Economic or Environmental Benefits and quantitative indicators are identified. Two types of indicators are identified: those measurable in the field, such as changes in productivity, production costs and resources or environmental changes; and those measurable at the aggregated level such as changes in consumption levels, market prices, economic gains and changes in (users and managers) attitudes, knowledge and capacities.

A methodological framework and participatory action research methods for Co-Management in coastal and inland fisheries were developed in collaboration with the Institute for Fisheries Management (IFM), including community participation and gender involvement in the conservation and management of fisheries and aquatic resources. A policy brief on co-management was elaborated for dissemination among policy makers in developing countries.

A “Wetlands Perspective” was developed on rural development challenges in the Mekong Region (including Lao PDR, Cambodia, Vietnam and Thailand), giving special attention to the livelihoods of poor people and promoting awareness and long-term institutional changes. The research-dialogue process fostered the capacity for networking within and between governments.

A number of methodologies on economic valuation of coral reefs were identified and disseminated in collaboration with the International Coral Reef Action Network (ICRAN). These were based on research, reviews and discussions such as those included in the Proceedings of the “International Workshop on Economic Valuation and Policy Priorities for Sustainable Management of Coral Reef”, identifying future economic and policy research directions relevant to the sustainable management of coral reefs.

b) Models and analyses

A global general equilibrium model on fish supply and demand, as part of the world markets for agricultural products, was developed in partnership with the International Food Policy Research Institute (IFPRI) and led to the publication of the book “Fish To 2020: supply and demand in changing global markets”. The model allows for forecasts and analysis of trade of capture fisheries and aquaculture products at global and regional levels. It also allows for the examination of expected changes in capture fisheries and

aquaculture production and trade and their probable effects on regional settings, the environment and the poor, for policy and decision making purposes. In addition, a specific version of the general equilibrium model was prepared for Asia in association with national government institutions, universities and research centers from nine countries (Bangladesh, China, India, Indonesia, Malaysia, the Philippines, Sri Lanka, Thailand and Vietnam).

Econometric models, allowing for comparative static analyses (i.e. with and without project scenarios), were also constructed and applied for ex-post impact assessment of Integrated Agriculture Aquaculture (IAA) projects in Asia (e.g. Bangladesh and Philippines) and Sub-Saharan Africa (Malawi). These models do not include formal consideration of environmental impacts caused by technological externalities of IAA technologies and practices, or the aggregated effects of their adoption and development. Bio-economic models for analysis of fishing capacity in the Gulf of Thailand were also constructed and applied.

PRIAP also contributed to the design of a Bayesian model (BayFish) for the management of water flows to optimize aquatic resource production in the Mekong River Basin, developed under the BGRRP.

c) Publications and training

Between 1999 and 2005, the Program has produced 189 publications, including books, journal articles, technical reports and workshop proceedings. Twenty-six percent (49) were refereed journal papers and 27% were documents authored or co-authored by the Center. Refereed publications included a number of journals such as: Aquaculture Economics and Management; International Journal of Socio Economics; Marine Resource Economics; Coastal Management Journal; Environmental and Development Economics; and Agriculture, Ecosystems and Environment. The average publication rate in refereed journals for 2005 was one, considering a total of 12 publications and 12 Ph.D. According to the analysis provided in Chapter 4, the average publication rate was 0.56 per year for the period 1999-2004.

A total of 35 Training Programs have been conducted between 199 and 2005, with a total of 593 trainees from 16 countries. During the same period, 99 workshops were held to present, discuss and/or disseminate intermediate or final outputs listed above.

Outcomes

A summary of main outcomes of the Program for the period of interest is as follows:

- i) Community-based organizations have been established and fisheries management principles have been practiced as result of the empowerment of co-management approaches applied at local level (e.g. Bangladesh and the Mekong River Basin). For example, 25,000 poor fisher families were organized in Bangladesh.
- ii) Community-based management projects and approaches applied to inland water management in Bangladesh have contributed to the creation of 164 fish sanctuaries in 81 water bodies.
- iii) Inter-ministerial dialogue on wetlands and fisheries policies in the Mekong River Basin evolved from community-based management (co-management) project and research, legal and institutional framework research and advisory reports.

- iv) Improved linkages and networking on wetlands management between institutions, especially in the Mekong Region.
- v) Establishment of access rights in open waters to poor fishers have resulted from co-management research, capacity building and networking.
- vi) Four MSc. theses on economic valuation and policy development in Cambodian fisheries were completed by students from the Imperial College and the University of Portsmouth, UK.

Examples of outcomes of other type of research conducted under the Program, are: valuation of aquatic resources; fish supply and demand model and forecasting at the global level and in nine countries in Asia. *Ex-ante* and *ex-post* impact assessment of research are yet to be realized at regional and national levels. This realization process is dependent not only on the means for dissemination and transfer of the concepts, methods and tools generated but also on the need for training, symposium and workshop participants to get familiar with, and fully comprehend, the outputs made available to them.

Impacts

Examples of some local project site related impacts are the short to medium term improvements in income and food availability for local people directly related to a project site or its zone of influence, like those in Bangladesh and the Mekong region related to co-management and common use rights in fisheries. The establishment of fish sanctuaries in inland waters constitutes a local contribution to inland fish resources and environmental conservation (e.g. there was a 14% increase in fish diversity in project water bodies), but their long-term positive effects at national level are to yet be seen.

Panel's Assessment

Assessment of the Program's performance during the period of interest is based on the 2001 CCER of PRIAP, as well as on the Panel reviews of the results shown, including an analysis of research-to-impact pathways and international recognition awards, among other aspects.

The Panel considers that overall the Program's outputs and outcomes are a positive step toward the long-term goals of poverty alleviation and hunger reduction in developing countries by improving fisheries and aquaculture.

The Panel believes that the goals of this program are fundamental for the overall achievement of the Center's mission and long-term objectives of reducing poverty and hunger in developing countries by improving fisheries and aquaculture. To realize its full potential for impact, it is essential that the Program's efforts and activities are conducted in an integrated manner not only with counterparts within the Center but also with its partners at national, regional and international levels. From information gathered, the Panel is pleased to observe that the Program activities and scientists have been consistently working towards such a harmonious approach, as may be witnessed by the co-management work conducted in Bangladesh and the Mekong Region, as well as, in the ex-post impact analysis of the implementation of IAA by the BGRRP in SSA and Asia.

a) Research

The Program is conducting relevant research which has led to the generation of frameworks, guidelines, methods, models and analyses to generate knowledge and information necessary to priorities and conduct research supporting the design and implementation of development and management policy in fisheries and aquaculture in developing countries.

b) Frameworks and guidelines

The Panel commends the Center and the Program for establishing an Impact pathway analysis process that includes the three important stages of the impact assessment cycle (i.e. prospective evaluation, monitoring and evaluation, and retrospective evaluation).

The impact pathway analysis framework is based on a holistic approach to analyzing and gaining understanding of the fisheries and aquaculture sector. Three types of research have been rightly identified, as well as the type of indicators to be used and the levels at which their measurement needs to take place. The framework also recognizes and indicates the need for a two-way approach and emphasizes the important role of feedback. In addition to the measurement of economic and environmental impacts, the framework also includes analysis of impacts on regulations and institutional arrangements for fisheries and aquaculture development and management. Even though further explanation of the participatory process adopted is necessary, the framework does include mechanisms to incorporate feedback from relevant stakeholders. Further elaboration is, however, required on how ex-post impact assessment results feed into research planning

In the Panel's view, the framework is pointing towards an effective measurement of expected and required impacts from research conducted by the Center.

From conversations with the two DDs and the DG, the Panel was able to confirm its view that the developed framework for impact pathway assessment has not been systematically applied to the planning and prioritization of research in the Center. Nonetheless, this framework and lessons learned during its development stage have been partially applied by the Center scientists while planning or implementing individual projects or regional project portfolios (e.g. prioritization exercise for the Carp-1 Project and in the ESEA Regional portfolio).

The relevancy of participatory action research for Co-Management in coastal and inland fisheries, including the research dialogue process between governments, is shown by the documented outcomes regarding the establishment (Bangladesh) and the modification (Mekong region) of community use rights in fisheries. The appropriateness of policy briefs and guidelines on co-management have also been appreciated by government officials, as there has been immediate influence in fisheries regulations. Long-term impact, however, is yet to be seen, as stakeholders need to get familiar with, and fully comprehend, the outputs made available to them

The discussion and application of methods for valuation of coral reefs and wetlands reflects a good starting point for the generation of knowledge with respect to the importance of this type of complex ecosystems. Completion at the University of Portsmouth (UK) of four MSc theses on economic valuation of wetlands in Cambodian

fisheries (as part of the Center's partnership with the university, demonstrates a certain influence on knowledge generation. Results from valuation of aquatic resources in Cambodia have raised awareness among officials in multiple national and international agencies and NGOs in various countries in the Mekong region. The Panel commends this line of work and its influence on national and regional institutions in Asia. In the Panel's view interesting benefits and improvements could be obtained from a stronger interaction with the Bayesian type of modelling conducted in the Mekong region and the developments planned for it. Additional discussion on the role of valuation and its relative importance for policy design and decision making is worthwhile in order to identify its real contribution to the long-term goals.

c) Models and analyses

The Panel joins the international community in commending the Program and the Center on their involvement in the development of the first world (Fish to 2020) and national (Nine Asian Countries) general equilibrium fish supply and demand models. It recognizes the relevance of this type of modelling in the generation of required knowledge and information to support policy and decision making with respect to the development and management of fisheries and aquaculture and both global and national levels. It also commends the Program for recognizing the need to improve the accuracy of information required for this type of modelling thus allowing its application in nine Asian countries.

However, the Panel sees two areas where this line of work requires further development. First, the existing models are of static nature lacking proper consideration for non-negligible dynamic (inter-temporal) effects of fisheries and aquaculture development. Second, there is no evidence of proper consideration of environmental impacts arising from technological externalities of fisheries and aquaculture technologies and activities. Thus, consideration of dynamic modelling and inclusion of environmental impacts are relevant as estimation of, and forecast results obtained, with or without the inclusion of environmental costs and effects, not to mention the consideration of dynamic pathways, will most probably be significantly different.

Models for ex-post impact assessment and analysis used to document the impact of the Center's research on IAA in Asia and SSA are seen as having properly followed standard concepts and tools of economics and econometrics. However, similar improvements apply with respect to the need to include environmental impacts and dynamic modelling.

In search of appropriate tools for decisions making, *the Panel recommends the Center expand its modelling work on the supply and demand of fisheries and aquaculture and undertake additional ex-post impact assessment in aquaculture, paying particularly attention in both cases to technological environmental impacts and non-negligible dynamic (inter-temporal) effects of fisheries and aquaculture activities.*

d) Scientific Staff

According to official Center data, in 2005, the Program ran a total of 22 projects with 18 professional scientists. Given the geographical span of projects conducted by the Program and the fact that its scientists also collaborate with several projects across disciplines and regions, Panel is concerned about the minimal amount of time that on average each of them dedicated to meet all project requirements. This is also sadly

reflected in the average ratio of publications, one of the lowest in the Center (0.56), for the PhD. Despite the increase in publications reflected in the 2005 data, only 1.09 articles were published in refereed journals. This situation is further characterized by the fact that during the review period the average annual number of total publications is only 27, and only 14 in 2005.

The situation of understaffing reported in the 2001 CCER of the Program showed improvement up until 2005. Nonetheless, the information available to the Panel suggests that the number of scientists has significantly decreased (February 2006). The Program is currently without a Discipline Director and the position is only expected to be filled by 2007. At the moment, the DG is acting as Discipline Director.

e) Training and Publications

Training, symposia, seminars, workshops and other dissemination means used by the Program have contributed to the process of knowledge and tool transfer (i.e. outcome generation). There are some indications that contributions have been made to achieve long-term impacts at the project-site or local level (i.e. income improvements and sanctuaries). Contribution to national, regional or global impacts has yet to be monitored.

f) Partnership

During the review period, PRIAP has been very involved in partnering with various national and regional government institutions, NGOs, universities in Bangladesh, India, the Mekong Region and Sub-Saharan Africa. The Program has also collaborated with intergovernmental bodies like the Mekong River Commission and other regional organizations like SEAFDEC. It continues to actively collaborate with the Collective Action and Property Rights (CAPRI), an inter-Center CGIAR System initiative.

g) Gender aspects

Community based and co-management projects in Bangladesh and the Mekong region have involved women in their work from the outset. Women have played a particular role in production and social-institutional arrangements for fisheries and aquaculture management. Positive effects on women empowerment and improvement of their social status in local fisheries management and aquaculture in inland waters of developing countries (e.g. Bangladesh) have been documented by the Center. Few examples of activities directly dealing with gender issues are: (i) a Project on Regional Capacity Building for Gender, Trade and Sustainable Livelihoods Analysis 2002-2003; (ii) Community Participation and Gender Involvement in the Conservation and Management of Fisheries and Aquatic Resources in the Mekong Delta of Vietnam; and, (iii) Global Symposium on Women in Fisheries, Sixth Asian Fisheries Forum, 29 November 2001, Kaohsiung, Taiwan, which led to publication of the article "From women in fisheries to gender and fisheries" (Williams et al.).

In the Panel's view the Program should look for ways and approaches to priorities and systematically cover gender issues across all relevant Center activities.

h) Center-wide issues from PRIAP perspective

The Panel is pleased with the successful definition of an adequate framework for Impact pathway analysis. However, the Panel suggests that further efforts are required to document the impacts of past research projects, using a systematic formulation of the

research domain. The Panel believes that the Program should lead efforts within the Center to define the above mentioned research space and further suggests that a holistic and dynamic approach should be adopted to integrate disciplines, i.e. to move from multidisciplinary to interdisciplinary, in order to contribute to the attainment of sustainable development (see Chapter 2).

3.3 Future Directions

3.3.1 Aquaculture and Genetic Improvement Discipline

Under the new research structure of WFC, projects relevant to capture fisheries under FRRP will revert to the NRM discipline while projects related to aquaculture will join former BGRRP projects within the purview of the Aquaculture and Genetic Improvement Discipline (AGID).

AGID is yet to elaborate a disciplinary strategy and program. However, the science in both the IAA and the DSAP as well as in a range of regional projects in the 2006-2008 MTP indicate that as resource poor farmers intensify their aquaculture operations, feed costs become an increasingly major component of their operational costs.

BGRRP have also defined three main axes for future research:

- Refinements of methodologies: more precise evaluations of genetic values of individuals or families, new traits, introduction of molecular techniques. In this area an effort will be made to analyze the GIFT database and publish the main results.
- Genetic improvement of new species: in addition to carps and tilapias the program will investigate other species according their biological traits (ability to control reproduction, growth, survival, etc.) and their social and economic importance in partner countries. African catfish (*Clarias gariepinus*) and freshwater prawn (*Macrobrachium rosenbergii*) are among the candidates for this new investment.
- Regional expansion: the program will develop and strengthen relations with partner organizations in several Asian and African countries in order to establish sustainable genetic improvement programs in these countries.

These three main axes will be used to present the Panel's views on AGID's future strategy. More general comments follow.

The thematic axes

a) Advances in fish nutrition to farm-based feeds for resource poor farmers

As resource-poor farmers intensify their aquaculture operations, most of them still rely on farm-based feeds and the diversity of such feeds is, therefore, huge. The nutrient requirements of farmed fish, particularly under the extensive and semi-intensive farming systems adopted by poor farmers, are not well understood. Interactions between external inputs (pellets, organic manure) and internal pond food web can lead to low technical and economical efficiency of these inputs. As a result, research on farm-based feeds is different from the traditional dose-response approach used in fish nutritional research. This cutting edge nutritional research could be carried out (on request of WorldFish by partners from ARIs, while WorldFish focuses on integrating knowledge on nutrient utilization, production/food chain dynamics into an adaptive model capable of making meaningful predictions of the response to different feed and other inputs, under different production conditions and evolving practices of aquaculture intensification.

The Panel strongly supports such an investment as is identified among the eight priority areas where WorldFish wants “to make major contributions to the primary science literature” in the future. It emphasizes, however, the need to move from traditional empirical approaches, with mainly local relevance, to more analytical approaches leading to “International Public Knowledge” with a large spectrum of potential applications.

b) Refinements of methodologies

This area (“a systematic approach to genetic improvement programs for aquatic species”) is also a high priority area. As government agencies and NGOs are now conducting genetic improvement programs, WorldFish proposes to place greater emphasis on refining the technology. The main goals would be:

- to generate knowledge to implement molecular tools (marker assisted selection, parentage assignment, etc.);
- to develop divergent lines for disease resistance; and
- to investigate the genetics of traits as fillet yield, flesh quality and variation of sex-ratio in response to temperature treatment.

The Panel fully agrees with the importance and relevance of this methodological investment for developing new and efficient methods for genetic improvement of aquatic species. The proper integration of molecular tools will be one of the key issues for the future.

The Panel advises the Center to pay attention to the context in which it uses the word “efficient”. This word should not be limited to maximization of genetic progress per generation in the short term but should integrate cost/benefit analysis, practicability and sustainability in the various contexts of developing countries (including those without efficient NARS) and long term conservation of genetic variability of selected stocks.

In the same way, the Panel supports the investment in the analysis and publication of the GIFT program. The Panel suggests that the GIFT database should be considered as an international public good (IPG) and opened to cooperative investigations between WorldFish scientists and geneticists of various countries. Moreover, the Panel encourages further investigations on the biological characteristics of GIFT strain (metabolism, feeding behavior, nutritional efficiency for different nutrients, effect of stocking density, etc.) in comparison with a proper control group. The possibility of creating, using the cryobank, a proper control population representing the founder gene pool should be considered.

c) New species and regional expansion

The Panel suggests that at least in the short term and considering the available staff, the investment in new species should be cautious and supported by a strong partnership allowing WorldFish to act mainly as a methodological resource Center. In the same way, the Panel approves the commitment of the Center in different Asian and African countries but suggests a global strategy be defined in which each local program will systematically have a double dimension: a practical contribution to the local development of aquaculture and a cognitive contribution to genetic improvement strategies.

General comments

a) Integration into the “Aquaculture and genetic improvement” discipline

The integration of BGRPP in the new “Aquaculture and genetic improvement” discipline and the stimulation through the “Matrix” of interactions between discipline leaders and regional portfolio leaders is a highly strategic decision and raises several issues for the definition of policy in the area of genetic improvement.

Until now, aquaculture projects have been developed in a separate program and with a very systemic and integrative approach starting from farmers’ practices and constraints for defining appropriate aquaculture activities. At the opposite end, the rationale for genetic improvement was based much more on the production of a “technological package” (improved strains and related aquaculture practices) that farmers were encouraged to adopt. While the Panel considers that the coming together of these two approaches under the same “discipline” has high potential, it believes the discipline leader will need to dedicate particular attention and consideration to the issue in order to avoid a simple “co-habitation”. As one of the key areas for this integration is an efficient interface between genetics and nutrition, the Panel suggests stimulating ambitious and long term cooperation between those two areas. An issue requiring joint investigation is to aim at a more precise estimation and understanding of genotype x environment interactions that are crucial for the definition of dissemination policy of improved strains. Some results from the GIFT program seem to indicate low G x E interactions in different pond culture systems but recent results suggest that factors such as density of fish (comparison between cages and ponds) could create large interactions. In the same way, the dialogue with regional portfolio leaders will be crucial to adapt genetic improvement strategies to needs and constraints of local situations, especially in Africa.

The “Fish to 2020” report has clearly underlined the importance of aquaculture for fish production in the future. A high growth rate of aquaculture production of low value food fish in developing countries appears a key issue. Related to this is the need for a clearer vision of the types of aquaculture that can and will answer this challenge in order to develop a relevant definition of priorities for genetic improvement, i.e. which species? Mono or polyculture systems? Which intensification factors (labor, nutrients)? Which investors? In which countries? Will a simple dichotomy between “poor farmers” (the targets of WFC) and “industrial farmers” (not to be helped) remain relevant? Will the growth of production be mainly due to new farmers or to a “scaling-up” of existing farms?

Two points are especially sensitive for this scaling-up of fish farms: (i) some intermediate options in terms of intensification could be less profitable than extreme options (very extensive or very intensive) as is the case, for example, in Egypt. The question arises as to how farmers can be helped to pass through this “no profit land”. (ii) scaling up can be achieved through various options: internal growth, acquisition of smaller and less efficient farms or development of producer co-operatives. Here the question is whether aquaculture policy should encourage one of these options and why.

The Panel suggests that to develop this perspective correctly, in-depth dialogues between social and biotechnical scientists are required, for which WorldFish appears to be the relevant convenor and facilitator. Such a project is not only of relevance and interest to WorldFish activities but for all genetic improvement programs in developing countries.

b) Biodiversity and genetic resources policy

In this area, EPMR2 recognized that ICLARM had played a leading role and should “continue to support the CDB and its associated organizations.” From 1999 to 2005, various activities have been developed in this domain, primarily although not only within the BGR program: management and improvement of data bases (FISHBASE); development of management models for freshwater systems aiming at a better conservation of species biodiversity; use of genetic markers for the characterization and management of wild or domestic populations (fish but also invertebrates for coastal aquaculture), development of tools to assess risks associated with introductions of alien species for aquaculture.

The range of activities has been very large both in terms of scientific disciplines (from genetics to socio-economy) and mode of intervention (laboratory studies, synthesis, problematic papers, declarations, development of national guidelines) and these activities are under review by the EC, one of the co-sponsors.

Characterization and preservation of genetic resources (in situ population genetic studies, creation and maintenance of new domestic gene pools, sperm cryopreservation) does not seem to be considered as a specific and relevant activity for the future. The Panel considers that the strategy of WorldFish in this area has to be defined. Such a strategy should concern both NRM and AGI disciplines but also PESS (economic and legal aspects) and include a broader spectrum of species and aquaculture systems that genetic improvement *stricto sensu*.

The connected issue of environmental impacts of improved strain and alien species, which was considered as a main issue by the EPMR2 Panel, has been the object of rather limited approaches (see Ia: enquiries among farmers in Philippines, Nairobi and Dhaka declarations).

Considering the rapid development of aquaculture in developing countries and the increasing demand for dissemination of a few improved strains, from sometimes only non-local species, *the Panel recommends that future efforts be made in defining on a pragmatic and objective basis, the acceptable dissemination area of an improved strain, and the realistic monitoring that should be implemented in relation to this dissemination.*

3.3.2 *Natural Resource Management Discipline*

The creation of the Natural Resource Management Discipline provided an opportunity to reassess the strategic directions needed to maximize its contribution to the Center’s Mission in order to make a significant impact on poverty reduction and increased food security through improved fisheries and aquaculture. The Discipline grew out of the Coastal and Freshwater Programs that had served the Center since 1998. These programs, and their predecessors, served the Center well and provided significant contributions. Nevertheless, changes in the external environment necessitated a change in approach.. The Center’s overall response to this need to evolve and adapt is summarized in the *Strategic Update 2005*. This NRM strategy is embedded in the broader goals of the Center articulated in that document and in the Key Performance Goals. Overarching goals are provided by the MDGs and the goals of the CG system.

Recent reviews of the Coastal and Freshwater programs as well as the East and Southeast Asia Portfolio have highlighted areas for improvement in NRM research. While noting

significant output, the reviews suggested: (i) better integration with other Disciplines, (ii) greater synergy among projects in regions where the Center is active, (iii) building a critical mass of expertise in priority areas, and (iv) building more effective partnerships. The Discipline's own analysis led to similar conclusions, but also suggested the portfolio of projects is highly unbalanced. For example, 49% of the total project budget (including grant funding) is spent on FishBase and Reefbase, and very little is spent in Africa. Further, much of the research exists as small projects in different places. For example, there is no coastal or marine research done in the Mekong region, South Asia, or Africa, and there is no freshwater research done in South East Asia. This situation does not maximize leverage in attracting funding or generalizing research outputs.

Future directions

In response to the external and internal reviews and analyses, NRM has refocused its strategy on a smaller number of research topics, adapting others, and reducing or phasing out the current investments in molecular genetics and the technical aspects of reseeded marine fisheries that do not maximize contributions to the Center's Mission. This latter process began with the closure of the molecular genetics laboratory. Current projects and commitments will end in March 2006. Scaling back in some areas will allow the Discipline to focus on others. *Enhanced small-scale fisheries will be the unifying theme that will bind NRM research in 2006-2007.* All other areas of research will be judged by their capacity to contribute to enhanced SSF. Key areas for research identified for 2006-2007 include: geospatial sciences and geoinformatics, improving resilience of inland fisheries, and assessment and management of coastal fisheries in Aceh. The Panel endorses this approach. In order for the new Discipline-Portfolio matrix structure to deliver its full potential, the Panel suggests that NRM take advantage of the new structure to increase integration across Disciplines, as outlined in the Strategy Update – notably in relation to PESS; seek greater synergy across projects; and build critical mass of expertise in the priority area of small-scale fisheries management and socioeconomics.

One of the major tasks for the future is to continue to “develop tools for improved management of small-scale fisheries”. The Panel believes that critical analysis of the broad approaches to this problem, and the technical tools available indicate that current and historical methods are not achieving the successes needed. Easy targets in this reappraisal are the single-species dynamic pool methods developed in the 1950's, which remain the backbone of fisheries assessments in much of the developing world, particularly in freshwater fisheries. The current swing to more people-focused socio-economic methods may be criticized for neglecting the ecological constraints that limit fisheries production. The Panel urges WorldFish to seek, with partners such as FAO, to be at the forefront for developing new methods that view management of small-scale fisheries as a socio-ecological problem where a technological solution may not be ideal. Such a change in emphasis could lead to much more effective SSF management. There may also be a need to build on exciting developments in the use of Bayesian belief theory (allows for dynamic integration of empirical knowledge into modelling) to integrate the many and varied variables relevant to developing and implementing management regimes. The Panel notes that the use of these tools in the Mekong shows great promise. Finally, there is a need to place small-scale fisheries management more effectively within the broader political, economic and biophysical environments. The Panel considers it crucial that this last challenge be overcome if small scale fisheries are to prosper in the long-term. Threats from outside the restrictive domain of fisheries management, for example, damming rivers, present the most insoluble threats.

In addition to the development of innovative management for small-scale fisheries there is a need for “comparative analysis of alternative governance and institutional arrangements”. Through the strategic alliances developed with FAO and ARIs, the Panel considers that WorldFish should adopt an interdisciplinary approach to examine this question. A consensus has emerged among development institutions such as the World Bank and FAO as well as many regional and national fisheries bodies that improving outcomes for poor people who depend on fisheries for food and livelihood requires a major focus on governance and institutions. WorldFish should strengthen its capability to work with partners in assessing, synthesizing, and communicating lessons learnt in small-scale fisheries governance so that they can be adapted to the widest possible number of developing countries.

Few analytical tools, however, provide decision-makers with a means to appropriately assess institutional options for small-scale fisheries in their social, economic, and political context. The Panel believes that the institutional “fit” of various management systems and their resilience to change needs to be tracked, understood, and the lessons learned be subsequently used to strengthen capacity to design and adapt sustainable management systems, and to influence governance arrangements. However, in order to do so, there is an urgent need for a coherent framework that links the multiple dimensions and scales of aquatic resources governance, as well as tools that help stakeholders assess the fit between institutional options and local conditions. It will be important to test whether and how improved tools and approaches for assessing aquatic resources governance actually enable stakeholders to better manage aquatic resources at the various scales and consequently play a role in meeting development objectives.

The reorganization of the programs into the Natural Resource Management discipline allows for synergy across portfolios and hence expansion and transfer of technologies to new regions, but it has brought to light some major weaknesses. While the Panel observes that the portfolio of projects is highly unbalanced with a preponderance of projects on stock enhancement in the South Pacific, global databases, and ecosystem management in East and SE Asia, it also recognizes that there is a need for focus on particular areas or systems. In addition, the Panel notes that the Discipline is below critical mass of scientists. Apart from the Discipline Director and one Portfolio Director, NRM only has 7 PhD IRS scientists, 1 non-PhD position and 1 PhD RRS, plus NRS staff.

3.3.3 Policy, Economics and Social Sciences Discipline

In 2005, the Policy Research and Impact Assessment Program (PRIAP) was renamed “Policy, Economics and Social Sciences, (PESS)” and is considered now as one of the three “Disciplines” defined by the Center.

PESS intermediate goals are to contribute to ensuring that (i) aquatic resources are managed in a sustainable, participatory and equitable manner; (ii) aquatic resources are valued and their contribution reflected in national and international development planning; and (iii) impact of aquatic resources research and development are assessed and priorities are set accordingly.

a) The thematic areas

The following five areas represent a continuation of the work done under PRIAP, either led by the “Discipline” or conducted in collaboration with others. The Center considers that PESS should see these as its future directions:

- Policy and Macroeconomic Analysis,
- Trade and Market Analysis,
- Legal, Institutional and Governance,
- Natural Resources Valuation and,
- Impact Assessment

Evolutions may be identified under each of these five research areas. Under *Policy and Macroeconomic Analysis* the Program proposes moving from global analysis (e.g. Fish to 2020) to the generation of synthesis and global advocacy outputs, along with the elaboration of policy briefs for use by regional and national agencies. In addition, elaboration of decision support tools for policy making is proposed. The second change under this research area implies a change from regional models/analysis (Asia Fish) to generating outputs under Trade and Market Analysis research area.

Under *Trade and Market Analysis*, the Center proposes a shift from consumption and market chain type of analysis and from studying the economics of small-scale producers, to analysis on impact of globalization and trade policies on the poor. Also, a move towards research on Legal, institutional and governance aspects is proposed.

Under the *Legal, institutional and governance* research area, the Discipline wants to move from co-management, community based management and analysis of conflicts and surplus fishing capacity towards research aimed at enabling small-scale producers to move up along the scale of operation and specialized/intensity and benefit from commercial-scale development and, to the analysis of implications of decentralized governance on access to resources.

With respect to the *Natural Resource Valuation research*, the Discipline proposes the complement of wetlands and coral reefs valuation work with analysis and evaluation of interactions between humans and natural resources and biodiversity, including gender analysis. Future work in valuation of natural resources will be also related to impact assessment.

Work on *Impact Assessment* will go from the ex post analysis of the transfer of the GIFT technology and on the research on Integrated Agriculture-Aquaculture to further developments, including: analysis of impacts from natural resources management and knowledge-intensive technologies, the analysis and assessment of impacts on biophysical and socio-economic aspects and the need to further institutionalize impact assessment approaches and methods.

In addition, the Discipline is planning to integrate research efforts with AGI. The research to be conducted will involve Legal, Institutional and Governance aspects. On the other hand work with NRM Discipline will in addition to the above aspects lay emphasis on Natural Resources Valuation and Impact Assessment.

Additional skills required to implement this evolution are in: geomatics and geoinformatic tools, bio-economic modelling, trade and macroeconomic analyses, tools for the analysis of institutional and governance aspects, ecological / resource economics and, gender analysis.

As reported in the 2006-2008 MTP, the Discipline will develop research that aims at generating a number of outputs for regional projects. examples are: the Pacific Regional Project (feasibility study of pearl farming); the ESEA Regional Project (A partial equilibrium model of the live reef fish trade and, Improved strategies and institutional arrangements for resource access, quality management, supply networks, markets and trade); and the SA Regional Project (Policy Analysis brief in macro impacts of CBFM approaches, Scaling up of CBFM approaches in managing resources, alternative models for institutionalizing Community based Organizations for management of water bodies or fisheries, a framework for better integration CBOs, a comprehensive macro model for the fisheries sector, etc). Research will also be developed in the Greater Mekong Regional Project (Capacity development, policy briefs, technical reports on Tonle Sap fisheries and aquatic resources valuation, case studies on aquatic resources governance and local livelihoods, Policy priorities for supporting local livelihoods in inland and coastal systems, etc.). In the Sub-Saharan Regional Project (Assessment of the role of market constraints in determining viability of aquaculture in the forest margin zones, Assessment of the contribution of market constraints to aquaculture development, development of methodology for assessing the impact of market constraints on aquaculture development, etc).

b) Assessment

As reflected in the above summary of research activities, areas and outputs planned for the period 2006-2008, the PESS Discipline will be facing significant commitments. It is clear that continuation and evolution of efforts in the five main research areas - from the social, economic, legal and institutional perspectives - are relevant if a contribution is to be made to the attainment of the long term goal of poverty alleviation.

In the Panel's view, the proposed areas and efforts are relevant in relation to the Center's and CGIAR system long term goals. Particularly important are the proposed evolutions on fisheries and aquaculture supply and demand models and analysis to support national and regional planning and decision making for development and management purposes. Proposed improvements in impact assessment modelling and analysis are also very important to generate relevant information on economic, social and environmental impacts of technical innovations and on new policy and institutional arrangements. Understanding and design of participatory approaches to improve people's behavior and institutional and legal arrangements are also important to define sound alternatives to attain sustainable development of fisheries and aquaculture.

With respect to staff, in 2005 PESS Discipline had a total of 18 scientists, out of which a total of 13 are Ph.D. (72%). Thus, overall, there seems to be a good representation of qualified scientist in PESS. However, a more detailed analysis of the composition of scientists reveals that for the same year only six of them may be classified as Senior according to their degree and position in the Center. When analyzing areas of specialization, the 2005 composition for Ph.D. is of six scientists related to natural resource economics, agricultural economics or political economy. The remaining Ph.D.

are involved in social, anthropological, institutional or development sciences, among others. One of the scientists comes from a natural resources science.

In terms of the regional distribution of the Ph.D., six are located in Penang (HQ), three are located in Egypt, two in Bangladesh and one in Cambodia and the Philippines, respectively. It is also necessary to consider that four of the Senior Ph.D. are Regional Portfolio Directors, which have a significant portion of their time tied with management activities.

Available data (EPMR documents # 17c and # 32 and CV data on scientific staff) on composition of the scientific staff for the discipline allowed the Panel to estimate the figures for February 2006. These estimates indicate staffing has been reduced to a total of 12 scientists of which 10 have a Ph.D. and five are considered by the Panel to be senior. Of these senior scientists four remain as Portfolio Directors of the Center.

Not only have two Senior scientists left the Center but the Panel was informed that PESS is presently without a Director and that the Director General is acting as Discipline Director. The Panel was informed that the Center does not plan to fill this position until 2007.

Given the large number of commitments planned (MTP 2006-2008 October presentation on future directions and the Center's document on Future Investments in Science), the wide geographical span for the research activities, the pressing social and economic needs of the regions and country considered and, the relatively small number of scientists currently residing within this Discipline, it is the Panel's view that a significant prioritization work is required to determine the relative importance and time scheduling of each research activity.

The MTP 2006-2008 shows a varying degree of specificity in the definition of the partners considered to conduct the above mentioned research. In many cases, it refers in general to government institutions, local NGOs and universities. Collaboration with important international NGOs and intergovernmental bodies is specified in some cases, as it is for the Mekong Region, but no information on collaboration with relevant ARIS was found. It is the view of the Panel that in the planning and prioritization process of these and future research areas and activities, significant attention must be given to the definition of the modes and strategies for partnership in the research work of the Program.

In addition, the long term goals of poverty alleviation and hunger reduction, call not only for a significant research on technical innovations but also for research providing knowledge and information on the social, economic and cultural aspects of fisheries and aquaculture, on institutional and legal arrangements and on environmental variability and resilience. Thus, the role of the PESS Discipline is crucial not only for the outputs and outcomes it may generate, but also in the definition and implementation of approaches and tools for research planning and prioritization that will ensure the Center's production of IPGs. In this context, the Panel suggests that the Discipline should play a leading role not only in its own research area, but also for the documentation of impacts from Center-wide research activities and in providing guidance to, and support of, the Center's planning, monitoring and evaluation in the short and long term.

In view of the critical role of the PESS discipline within the Center, the current breadth of its tasks as outlined in the 2006-08 MTP agenda and its current staff composition, the Panel recommends that the Center take action on the following:

- *secure a Discipline Director as soon as possible;*
- *conduct a strategic process of research planning and prioritization that enables the discipline to more precisely identify its research domain and a selected set of issues to produce significant IPGs; and,*
- *develop and apply a balanced growth policy for qualified scientific staff according to research priorities.*

3.4 Regional Portfolios

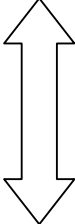
WorldFish has clustered its work into specific geographical areas where the Center seeks to maximize the impact through the combined effort of its scientists and partners. The Panel observed that the Center, through participatory/consultative processes, has elaborated regional strategies for SSA and WANA (2001), ESEA (2004) and has also produced a draft strategy for the Greater Mekong Region (GMR) in 2005. The ESEA and SSA/WANA strategies have been reviewed by CCER panels. A review of the activities of GMR is planned for 2006. In September 2004, in the context of the matrix management approach, Management appointed seven regional portfolio directors. This Chapter reviews the activities in the three regions for which regional strategies have been elaborated.

3.4.1 East and South-East Asia

The East and South East Asia Regional Program was established in September 2004 as part of the re-organization of the Center's operation under the matrix management approach. The region consists of a heterogeneous group of five countries –China, Indonesia, Malaysia, Philippines and Timor Leste - with respect to opportunities, aspirations for development and achievements with economies ranging from micro- to mega-scale. To ensure the needs of the different groups are met the Center conducted with stakeholders a detailed priority setting exercise using economic, environmental and biological criteria to determine the ranking of priority ecosystems. The results indicated more interest for activities in freshwaters and particularly aquaculture in ponds as a resource focus for research related to poverty reduction. Coastal capture fisheries is acknowledged as the principal ecosystem set because of its importance for supporting the livelihoods and food security of most poor in the region (See Fig.3.1).

The goals of the strategy include: food security and improved health, reducing poverty and improving livelihoods, sustaining aquatic ecosystems and improving knowledge and awareness of fish, poverty and environmental links. Thirteen key priority research areas that can be grouped into five subject areas (genetic improvement of tilapia and carps, coastal zone management and MPAs, coastal fisheries management, aquaculture excluding genetics and breeding, and social science) were identified and a MTP for 2006-2008 was elaborated. These areas represent priority areas of work for WorldFish and concerned Countries in a partnership mode.

Figure 3.1 Priority aquatic resources/ecosystems in ESEA

Resource Ecosystem	RANKING
Ponds	
Coastal waters (including estuaries and lagoons)	
Small water bodies, lakes and reservoir	
Floodplains, streams and rivers	
Coral reefs	
Continental Shelves/Open oceans	
	LOW

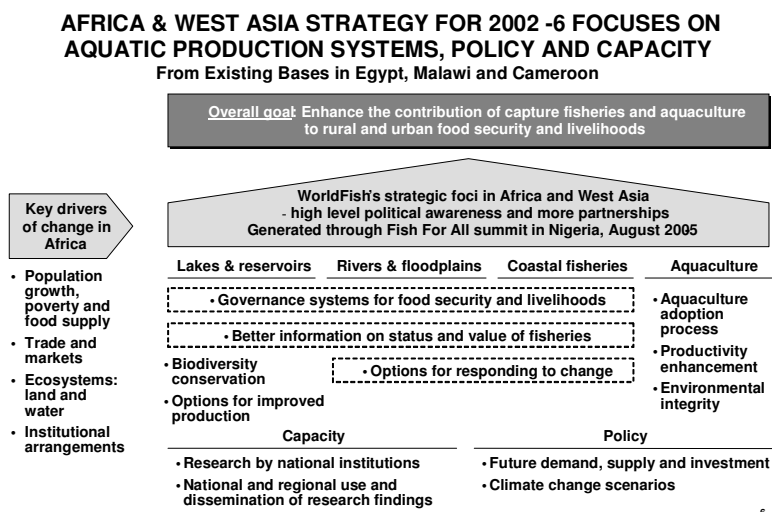
In the meantime, nine on-going projects are being implemented and the Center responded in a timely manner to the Indian Ocean Tsunami by collaborating with five other partners in the framework of the Consortium to Restore Shattered Livelihoods of Communities in Tsunami Affected Nations (CONSRN) to meet the immediate needs of affected communities (See Chapter 5).

The Panel considers the strategy to be appropriate, the quality of science for the on-going portfolio of projects to be good and from documentation made available to the Panel and its interaction with partners in three of the concerned Countries, is convinced that the outputs of the projects have contributed to the overall mission of the WorldFish Center. This observation underpins the conclusion reached by the CCER Panel. The Panel endorses the recommendations made by the CCER Panel to ensure that the suit of activities in support of the strategy is accomplished. The Panel, therefore, encourages the Center to pay particular attention to four recommendations that relate to i) the environmental impacts of aquaculture and environmental externalities; ii) the evaluation of MPAs; iii) production-marketing chain, ecological footprints and the extent to which MDGs are being met by research projects and, iv) interaction between food security and fish trade in developing countries. The Panel is pleased that the Center plans to take into account the recommendations of the CCER Panel, as appropriate, hold further consultations with stakeholders and eventually up-date the strategy.

3.4.2 Sub-Saharan Africa

The Center responded to one of the major recommendations by the Second EPMR that “ICLARM/WFC further develop its tactical plan for Africa and West Asia”, by developing in 2001 an ambitious strategy. The strategy was prepared through an extensive consultation process involving regional and international partners, including FAO, and provided an important opportunity to engage a wider regional constituency in guiding the future development of the Center’s work. The Panel confirms that the strategy is responsive to the development agenda of the region by focusing on small-scale fisheries and aquaculture, social/institutional/economic and policy parameters with a significant importance to developing and strengthening partnerships and capacity building. The main elements of this strategy are summarized in Figure 3.2.

Figure 3.2 WorldFish Strategy for Africa and West Asia



The Panel's view is that the goals of the strategy are relevant to the Mission of WorldFish and the CGIAR as well as the aspirations of fishing communities in the region. The Panel was informed that since 2002 the Strategy has provided the framework for specific efforts in capacity building and improvements in aquaculture and fish breeding. The Center's work has involved the participation of partners (government officials, NARs, NGOs and universities) with the capacity building component for NARs and government officials executed primarily, as appropriate, at the Abbassa facility in Egypt. The principal field activities have been concentrated in Malawi, with limited operations in Cameroon, Mozambique and Zambia.

The Panel endorses the conclusion of the CCER Panel that activities in Malawi have generated discernible impacts (see Chapter 3). The Panel also found ample evidence in documents, publications and through field visits that a) increased staff at the Abbassa facility has contributed to steady growth in research activities with spill-over effects in SSA, and b) work in Cameroon, Malawi, and Zambia generated a series of outputs in relation to IAA, fisheries co-management approaches, fisheries and watershed studies, genetic biodiversity of rainforest river and lake stocks of culturable fish species, and the identification of species of ornamental and economic value. In addition, WorldFish contributed to the elaboration of policy statements that have recently been adopted by SADC as regional planning documents. The Panel concurs with many of the recommendations made by the CCER Panel in connection with the strategy and on-going activities, and in particular "those related to partnerships, research remit and operational structure".

However it is the view of the Panel that the accomplishments so far, seen in the context of seven years, are small, highly localized and in no way correspond to the acclaimed importance the Center attaches to SSA. The Panel noted that of the five IRS ear-marked for SSA, three were appointed Portfolio Directors for SSA in September 2004 and two of the portfolio directors are still resident in Cairo. The Panel considers that WorldFish does not have the critical mass in the region to implement the ambitious strategy and fulfill the Center's goals. The Panel was informed that arrangements have been made to transfer the two Portfolio Directors to SSA and that two new staff members will be

appointed in April 2006 to fill a new office in Lusaka, Zambia and the other as an advisor to NEPAA, stationed in South Africa.

The Panel commends WorldFish for organizing, in collaboration with NEPAD, FAO and other partners, the NEPAD-Fish for All Summit in Nigeria in August 2005. The Summit produced a Declaration and an Action Plan. The latter catalogues activities that could be undertaken by WorldFish and other stakeholders to improve the livelihoods of fishing and farming communities through responsible fisheries and sustainable aquaculture development. The Panel ascertained from many WorldFish partners in the region and some donors that the summit was an important event in creating awareness and in stimulating the political will. However several partners also cautioned that without adequate follow-up, the summit would remain only an event.

The Panel reviewed two “Program Briefs” of collaboration between WorldFish and NEPAD which WorldFish had elaborated to advance the cause of the summit. The first program aims at enhancing the contribution of small-scale fisheries to Africa’s economic development and the second one is on sustainable aquaculture development. The Panel acknowledges that key components of both programs are themes in which the Center is presently working on in some sites in SSA and the program documents foresee “Fast Track Opportunities” to scale-out the outputs to other key countries. Considering that over the past seven years the Center’s contribution in SSA has been minimal (as explained previously), the Panel urges the Center to take advantage of this opportunity. The implementation of these programs affords to fine tune its modus operandi in the conduct of research, its delivery and dissemination mechanisms, so that the programs contribute to the attainment of MDGs through sustained development in aquaculture and improvements in small-scale capture fisheries.

Bearing in mind that many activities under fast track opportunities within the WorldFish – NEPAD initiative go beyond the realm of fisheries and/or aquaculture, *the Panel recommends that WorldFish explore opportunities for collaboration with other CG Centers, in particular IITA, WARDA, IRRI, CIFOR, IWMI, IFPRI and ICRAF, possibly within the context of task forces, to identify gaps in the application of IAA technology and methodology or for activities related to fisheries governance.*

In addition, WorldFish should closely follow and advise on the Programmatic and Structural Alignment of the CG in SSA on the basis of its on-going collaboration with IWMI on similar matters, but also with a view to capitalizing on the synergies and enhance efficiency gains that could be obtained by associating with the two sub-regional entities of West and Central Africa (WCA) and East and Southern Africa (ESA).

See also Chapter 5 for recommendations on capacity building and effective positioning on the research-to-development continuum.

3.4.3 West Asia and North Africa (WANA)

The WANA regional program was created in 1997 with the establishment of ICLARM in Egypt. The activities at the out-reach site were reviewed by the Second EPMR. The Panel made two recommendations and several suggestions relevant to Abbassa, to which the Center has responded as detailed in Appendix 4. In 2001, a common Strategy was elaborated for WANA and SSA. The difference is in the details as elaborated through MTPs taking into account the specificities of WANA. The work in WANA has been

limited to Egypt with a focus on fish breeding, pond management, hatchery technology and disease monitoring producing national public goods. A study on fish supply and demand was undertaken in Jordan and the Abbassa facility has served as a hub for capacity building for partners and government officials from SSA and WANA. WorldFish, in collaboration with the Government of Egypt, has produced an extensive plan on “Strengthening Egyptian Fish Production: International Perspectives”. The document presents a development framework for aquaculture development, outlines seven key approaches for meeting sectoral challenges and a timeline of interventions.

The Panel ascertained that the developments in the Abbassa facility have occurred in three phases:

- *Establishment Phase (1996-2000)*: characterized by the rehabilitation and construction of ponds, the refurbishing of offices, laboratory and capacity building facilities, recruitment of staff, other administrative tasks, etc.
- *Building Phase (2001-2005)*: the principal milestones include: emerging breeding programs on Nile Tilapia and *Clarias gariepinus*; solid research on pond production; some innovative technologies with regional applications; operation of demonstration farms; training of 130 regional trainees (65 SSA; 39 WANA); establishment of strategic partnerships with the University of Wageningen and other ARIs resulting in the training of 4 MScs; 3PhDs; while offering residence to 6 Post Docs. In addition, the WorldFish becomes a key player in aquaculture research and training in Egypt, interacts with the private sector and initial devolution of training to partners has started. The Panel was informed that the principal constraints or set backs included a slow development of the SSA program, limited partnership arrangements in SSA, uncertainty around the training program which is grant dependent, insufficient collaboration with ARIs, inadequate diversity of researchers at Abbassa and inadequate publication record. Despite these shortcomings, the Panel commends WorldFish for the achievements made at Abbassa over the past seven years.
- *Realizing Potential Phase (2006-2010)*: It is envisaged during this phase to: consolidate and expand breeding programs through networks, sustained program of research on pond production generating regional tools on feeds and fish health; transfer technology with NEPAD providing the vehicle for transfer and further development of technologies; consolidate training programs as part of the tri-nodal regional training network (Abbassa-Malawi-Nigeria), targeted at key constraints; and lastly, establish strategic partnerships with five ARIs and put in place regional teams of trainers. The emphasis in the Realizing Phase corresponds in part with the WANA MTP 2006-2008. The projects ear-marked in the 2006-2008 MTP for this region are essentially location specific (Egypt) with almost exactly the same outputs as some projects e.g. nutrition and pond dynamics in SSA. The Panel considers that it would, therefore, be possible to produce, in some cases, IPGs in the form of comparative analysis across countries. The Panel commends the Center for establishing the strategic partnership with the University of Wageningen for the training of graduate, mainly PhD students. It is the students themselves who undertake field work at Abbassa, avail themselves of appropriate laboratory facilities in Wageningen while benefiting from the dual supervision of WorldFish staff and professors overseas. The Panel encourages the Center to foster similar collaboration with other ARIs, for provision of high-level expertise in genetics, fish health and fish nutrition as well as pond dynamics. The BoT has endorsed the consolidation of the Abbassa Center into a regional training hub, and it is planned to organize approximately four regional

courses a year for about 200 trainees from SSA and WANA during a two year period as well as strengthening of the staff at the Site.

The Panel endorses the medium-term plan for Abbassa and taking into account the fact that the Discipline Director for AGI will be stationed in Cairo, offers the following suggestion: WorldFish should review the SSA/WANA Strategy in the light of recent changes in the region, capitalize on the substantial regional momentum that has been created in support of aquaculture development as a result of the NEPAD Fish for All summit, and develop as a priority, a global WorldFish approach/strategy to aquaculture in the context of AGI discipline as part of Aquaculture Campaign under the banner of Fish for All.

3.4.4 Greater Mekong Region

The Greater Mekong Region was established in 2004. The regional program has three main thrusts: the development of trade offs, wild capture fisheries management and sustainable aquaculture. These thrusts are on-going and would continue through 2006-2008. In the implementation of these thrusts the Regional Portfolio, put in place in September 2004, has elaborated a draft regional strategy to guide research in response to development challenges.

The strategy focuses on creating a platform for the exchange of lessons and experiences with emphasis on the independence to address difficult issues, ensure sustained partnerships particularly with CSO but also governments. The strategy envisages imbedding in activities cross regional perspectives, synthesize and effectively communicate research results. Based on past experiences, the strategy provides for aligning campaigns with regional research policy dialogue, to engage in national debates and enhance institutional, as opposed to individual, capacity. Implementation of the strategy will be facilitated by building on existing strengths and strong partnerships and by adopting a step-wise approach, beginning in Cambodia and progressively expanding to the other countries. The step-wise approach does not imply a single country focus, but rather that emphasis will be placed initially in Cambodia with limited activities in the other countries. The Panel commends the Center for the “practice oriented strategy” that has been developed for the GMR.

The principal outputs and outcomes of the GMR Program were given in Chapter 3. The work undertaken in GMR is relevant to the Mission of the WFC. The quality of the science has been evaluated by an EU commissioned review to be good. The Panel endorses this conclusion and also underpins the fact that the Program collects hydrological, ecological, social and economic data that could be useful in a wide variety of ways. Efficiency has been greatly enhanced by the degree of scientific collaboration and partnership pursued within the GMR and interaction with IWMI and scientists from outside the area, for example: South Africa, Australia, UK, Sri Lanka, Brazil, and Finland. However, in the Panel’s view, the Program needs additional social scientists to work at the interdisciplinary interface in the areas of local knowledge, development of consultation processes, governance of fisheries community organizations and the social and political context of policy decision making and thus add value to the science. It is suggested that social science expertise be sought.

Under the new matrix management system, these projects will align with the Natural Resources Management discipline. While a lot of data is being collected; there is a need

for more research to follow on from research data already compiled, particularly with regard to basin-wide management strategies and integration of local and regional activities. The Panel urges that the on-going work, particularly the collection of highly targeted primary data, as is the case in the portfolio, should be embraced and defined under the proposed new focus on small-scale fisheries development.

The Program has made a substantial contribution to capacity building particularly at the institutional level. As capacity increases in the region, it will be important for WorldFish to promote ecosystem-based fisheries management, possibly using the 'aquatic resources systems' approach. The GMR and the Mekong River (one of the world's great ecological systems) provide a great opportunity for such an integrated activity. It will require local, regional and national partnerships in which WorldFish may be well placed to help prioritize activities, promote collaboration and to play an important scientific coordination role. Such an approach will provide the opportunity to create alliances with other CGIAR centers, ARIs, NARs as well as relevant NGOs at regional and national levels.