PUBLIC AND PRIVATE PARTNERSHIPS IN AQUACULTURE: A CASE STUDY ON TILAPIA RESEARCH AND DEVELOPMENT

Edited by

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IDRC CRDI
WorldFish Center

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Preface

Inadequate supply of seed and poor growth of tropical finfish in various production systems are two of the major concerns of aquaculture sector in many developing countries. While significant achievements have been made for increasing production in case of crops and livestock through genetic improvement, in case of fish in spite of decades and centuries of domestication, the species presently being used in aquaculture operations are worse than their wild populations. To help address the problem, the public sector national institutions and an international organization based in Philippines developed a selective breeding technology for genetic improvement of tropical finfish using the Nile tilapia *(Oreochromis niloticus)* as a test species.

In Philippines, Nile tilapia is the second most important food fish for domestic consumption, next to milkfish. Genetic improvement research for this species has progressed significantly. Public sector institutions that have played a primary role in development of improved strains of the species have also worked on sustaining the genetic quality of stocks. They have ensured that the improved stocks are disseminated commercially for the benefit of more fishfarmers. However, in view of the enormous and complex resource requirements, there is tremendous challenge for the public sector institutions to sustain the cost of long-term genetic improvement and commercialization of the improved seed from the national breeding programs. In the crop sector, such a situation has encouraged the public sector institutions to involve the private sector as a partner in breeding programs and commercialization of the products. In the case of fish, a similar trend is now emerging. In Philippines, there is an increasing private sector participation in the production and dissemination of improved tilapias.

While engaging the private sector has increasingly become an option for the public sector institutions to commercialize the seed industry, the experience of crop sector indicates that the success of such collaboration still hinges on a number of requirements and conditions. Until now, the concept of effective partnerships is not well understood. It is not clear why real successes of collaborative initiatives have been very limited. In the fish sector, the issues that will have influence in achieving the development objectives of the genetic improvement programs initiated by the public sector institutions are not known.

Against this background, with financial support of the International Development Research Centre (IDRC) of Canada, the WorldFish Center and Philippine institutions, which compose the partners of the Tilapia Science Center, conducted an 18-month research in 2002-2004 to evaluate the evolving public-private partnerships and to determine their effects on the sustainability and achievement of development objectives in fish genetics research in Philippines.

The Philippine institutions are the Freshwater Aquaculture Center, College of Fisheries and the Phil-Fishgen of the Central Luzon State University; the National Freshwater Fisheries Technology Center; Bureau of Fisheries and Aquatic Resources of the Department of Agriculture; and GIFT Foundation International Inc.

The findings of this research were presented at the Stakeholders Workshop held on 25-27 June 2004 and on 21-23 January 2004 in Angeles City and Tagaytay City, Philippines, respectively. Participants in the workshops were representatives of various stakeholders groups (i.e., national aquatic research system, international organizations, advanced scientific institutions, private sector, hatchery operators and growout farmers) in Philippine tilapia research and development.

The workshops:

- discussed the roles of public and private sector institutions, the issues and constraints in collaborations;
- identified the effects of changing partnerships in accessibility of Philippine tilapia seed producers and growout farmers to improved strains;
- reviewed the levels of research and development investments by selected public and private sector institutions involved in tilapia genetic improvement research; and
- formulated recommendations for improving partnerships between public and private sectors in tilapia research and development.

Public and private partnerships in aquaculture: a case study on tilapia research and development documents the proceedings of the Stakeholders Workshops, including a synopsis of discussions and recommendations. There is evidence that there are elements contributing to the successful dissemination and wider adoption of products from genetic improvement research in crops. Hence, the papers presented in this book comprise not only those on tilapia but also on maize, one of the important crops in Philippines and where there is rich experience and relevant lessons that could be applied to fish.

The implementation of this research and the publication of this proceedings would not have been possible without the technical guidance and funding support provided by the Research on Knowledge Systems of IDRC. We also acknowledge the cooperation and significant contributions of all the institutions and individuals that participated in this research project.

Belen O. Acosta
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Editors

List of Acronyms

ADB	Asian Development Bank
AKVAFORSK	Institute of Aquaculture Research, Norway
BAR	Bureau of Agricultural Research
BAS	Bureau of Agricultural Statistics
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (France)
DA	Department of Agriculture
DFID	Department for International Development, UK
FAC/CLSU	Freshwater Aquaculture Center / Central Luzon State University
FAO	Food and Agriculture Organization of the United Nations
FaST	Freshwater Aquaculture Center Selected Tilapia
FIDC	Fishery Industry Development Council
GET-EXCEL	Genetically Enhanced Tilapia / Excellent strain that has competitive advantage with other tilapia strains for entrepreneurial livelihood projects
GFII	GIFT Foundation International, Inc.
GIFT	Genetically Improved Farmed Tilapia
GMIT	Genetic Manipulation for the Improvement of Tilapias
GMT	Genetically Male Tilapia
GST	GIFT Super Tilapia/GenoMar Supreme Tilapia
HACCP	hazard analysis critical control point
ICLARM	International Center for Living Aquatic Resources Management
IDRC	International Development Research Centre, Canada
INCRI	Indonesia Cereals Research Institute
INGA	International Network on Genetics in Aquaculture
IPR	intellectual property rights
ISAAA	International Service for the Acquisition of Agri-biotech Applications
LGU	local government unit
NBC	National Broodstock Center
NFFTC/BFAR	National Freshwater Fisheries Technology Center / Bureau of Fisheries and Aquatic Resources
NGO	nongovernment organization
NIFTDC	National Integrated Fisheries Technology Development Center
ODA	Overseas Development Administration
OPVs	open-pollinated varieties
PCAMRD	Philippine Council for Aquatic and Marine Research and Development
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PO	provincial office
RBC	Regional Broodstock Center
R&D	research and development
RF	Rockefeller Foundation
RoKS/IDRC	Research on Knowledge Systems / IDRC of Canada
ROS	Regional Outreach Station
TAMNET	Tropical Asian Maize Network
TSC	Tilapia Science Center
UNDP/DGIP	United Nations Development Programme, Division of Global and Interregional Programmes
UPMSI	University of the Philippines-Marine Science Institute
UPV	University of the Philippines in the Visayas
UWS	University of Wales Swansea

Public and Private Partnerships in Tilapia Research and Development: An Overview of Philippine Experience

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Abstract

The growth of tilapia industry in Philippines and elsewhere in the region is attributed mainly to development of genetic improvement technologies and improved tilapia strains by public sector institutions. As public sector institutions move towards further development, undertake widespread dissemination and engage in commercialization of improved tilapia strains, it has become necessary for some of these to establish partnerships with the private sector. Unlike in crops, the subject is still new in fish and information on changes that take place with evolving partnerships and changes in source of funding is not known. An 18-month research conducted in Philippines evaluated the effects of changing partnerships and source of funding for genetic research and dissemination of research outputs to end-users, through field surveys, gathering of secondary information and organization of stakeholder workshops.

The late 1990s witnessed greater private sector participation not only in dissemination of improved tilapia strains but also in research. Concomitant with this development are the changes that have taken place, including differences in nature of genetic research and development (R&D) activities; ownership rights to improved tilapia strains; and emergence of issues that influence dissemination of and access to these strains. These changes are most evident in the program concerning the Genetically Improved Farmed Tilapia (GIFT) strain, it being the only one that has established an alliance with a *for-profit* private sector company.

There is divergence in breeding goals due to difference in focus of clientele farmers during the public sector phase (GIFT Project) and private sector phase of GIFT breeding research (GenoMar-GIFT Foundation). Dissemination mechanism, which specifically targets the "small and poor" tilapia farmers, is lacking. Among farmers involved in hatchery operation, those with relatively higher level of education, access to investment capital and own larger areas of land are in a better position to receive the benefits of genetics-based technology from private sector collaboration. Linkages among research institutions, local government units and fish farmers are generally weak, suggesting the important role that private sector producers can play in the delivery of technical information.

While significant benefits have been achieved as a result of development of improved tilapia strains and public-private sector partnerships, a number of issues have emerged and need to be addressed which are presented in this paper.

Introduction

Fish is a vital component in food and nutritional security of people in developing countries. As world population continues to grow, the need for more food including fish is growing commensurately. The Asian Development Bank (2006) predicted that in Southeast Asia alone, the demand for fish will reach 23 million t by 2010, because of population growth and economic expansion. The Philippines is one of the countries in the Southeast Asian region where aquaculture has become increasingly important because of depletion of the country's fishery resources and due to the fact that fish is an essential commodity to the Filipino people and the economy. One of the commodities that is relevant to Philippine aquaculture is the tilapia (particularly *Oreochromis niloticus*). At present, this commodity ranks second behind milkfish in importance as a food fish for domestic consumption (Lopez et al. 2005; BFAR 2006).

The tilapia industry has become a fast-growing enterprise in the aquaculture sector in the country. National tilapia production increased from 16,000 t in 1976 to 145,868 t in 2004, representing an increase of more than 900% over nearly three decades (Abella, this vol.; Abella 2004). The immense growth of tilapia industry in Philippines and elsewhere in the region is attributed to several factors favoring production, foremost, being the development of genetic improvement technologies and improved tilapia strains - the main outputs of long-term genetic improvement research undertaken by the public sector institutions (national institutions and international organization based in Philippines). As institutions move towards further development and widespread dissemination and commercialization of improved tilapia strains, it has become necessary for some of these public sector institutions to establish partnerships with the private sector.

In the crop sector, public-private partnerships are increasingly being used as part of the mechanism in addressing global issues and in delivering the potential benefits of agricultural research and biotechnology in developing countries (Pinstrup-Andersen et al. 1999). However, unlike in crops where the implications of such partnerships have been well studied and established, in the case of fish, the subject is still new and information on the changes that take place with evolving partnerships is not known.

The Genetic Improvement of Farmed Tilapia (GIFT) Project implemented by the WorldFish Center and its partners in Philippines and Norway was the first major genetic improvement research on tropical finfish. This project provides an example of a public-funded partnership that evolved into a private sector collaboration involving a nonprofit foundation, private sector hatcheries and a *for-profit* private sector company. The institutional arrangements operated for nearly seven years but implications in a number of areas have not been studied.

The WorldFish Center and its research partners from Philippines – Freshwater Aquaculture Center of the Central Luzon State University (FAC/CLSU), National Freshwater Fisheries Technology Research Center of the Bureau of Fisheries and Aquatic Resources (NFFTC/BFAR) and GIFT Foundation International, Inc. (GFII) conducted an 18-month research to investigate the effects of changing partnerships and source of funding particularly on genetic R&D, delivery of research outputs to end-users and on level of funding and expenditures by public and private sector institutions in Philippines. Investigation covered the four genetically improved strains that are being disseminated by public and private sector institutions in Philippines under the Tilapia Science Center (TSC)[a] GIFT-GIFT Super Tilapia (GST); Genetically Enhanced Tilapia (GET-EXCEL); Genetically Male Tilapia (YY-GMT); and FAC Selected Tilapia (FAST). However, the focus of the research and observations presented here are the collaboration involving GIFT strain since this is the only program that has undergone changes in nature of partnerships and has involved alliance with a *for-profit* private sector company.

This paper summarizes the findings of the research study and presents a number of issues that need to be addressed.

Methods

The study was undertaken through field surveys, organization of stakeholders workshops and gathering of secondary information from reports and other publications.

Effects on R&D activities

Trends in tilapia genetic research of public and private sector institutions and how the development objective, genetic research outputs and major key players have been affected as a result of shifts in partnerships and nature of funding were studied through semi-structured interviews. Respondents were key informants from public sector institutions that formerly participated in the GIFT Project, the technical staff from the GFII and GenoMar's accredited hatchery operators in Philippines. Data were supplemented through secondary information obtained from reports and other publications.

Delivery of research outputs to end-users

Investigations focused on assessing the efficacy in

[a] TSC is a collaboration of institutions that are involved in research on various aspects of tilapia aquaculture and at the forefront of development and dissemination of improved strains of tilapia. These institutions, all located in the Science City of Muñoz, Philippines, are: CLSU-FAC and College of Fisheries, Philippine Department of Agriculture's (DA) BFAR through its NFFTC, Phil-Fishgen and GFII.

dissemination of improved tilapia strains by public and private sector institutions to immediate end-users (tilapia seed producers or hatcheries) and on determining the accessibility to research outputs by local tilapia seed producers through questionnaire surveys and organization of stakeholders workshops. The workshops brought together representatives of the various stakeholders groups in the tilapia industry to discuss and analyze issues and constraints, and formulate recommendations for effective partnerships on delivery and uptake of genetics-based technology.

Primary data were gathered through personal interviews of key informants from the Philippine institutions involved in the development of improved tilapias and the users of these fish. Among users, interviewed were the hatchery and growout farmers using the four strains (GIFT-GST, GET-EXCEL, YY-GMT and FAST) and are based in the four regions of the country, representing the major tilapia-producing areas (Region I-Ilocos, II-Cagayan Valley, III-Central Luzon and IV-Southern Tagalog) (Figure 1).

Levels of R&D funding and their effectiveness

This was assessed through understanding: (1) the manner in which institutions involved in TSC obtain the resources to conduct tilapia genetic improvement R&D; (2) how partnerships with the private sector are utilized to generate resources; and (3) the impact of these partnerships on the funding and resources available for tilapia R&D. Activities involved collation of secondary information, interviews/surveys and institutional analysis on the levels of investment and spending for R&D, including how these contributed to the overall effectiveness in meeting their research objectives.

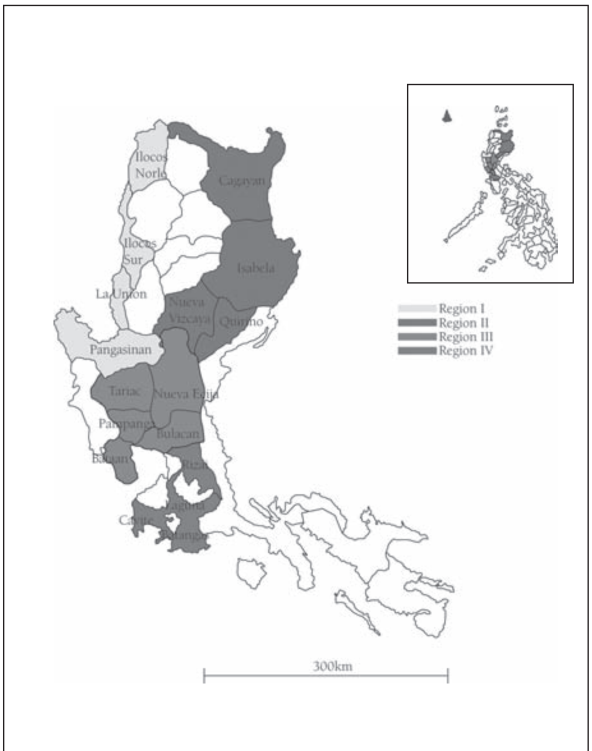

Figure 1. Map of the Philippines showing the study areas (Source: Sevilleja 2004)

Results and Discussions

Development of collaborations in tilapia genetics research

Public sector research programs

Similar to crops where research began with the public sector, early research for the genetic improvement of tilapias in Philippines was initiated in 1979 by the public sector institutions (FAC-CLSU and the WorldFish Center). Early research focused on improving the genetic quality of broodstocks of Nile tilapia using hybridization technique. This was undertaken in response to the growing concern in the tilapia industry with the deteriorating growth performance in many production systems and inadequate seed supply.

This was followed by genetic characterization studies which led to the conclusion that the genetic quality of farmed tilapia stocks in Philippines and elsewhere are of poor genetic status (Macaranas *et al*. 1986; Pullin 1988; Pullin and Capili 1988). Recognizing the pressing need to address these issues, government institutions and international organizations initiated strategic research programs aimed at developing the improved tilapia strains (Abella, this vol.).

One major example of such programs is the research initiative on GIFT that resulted in the development of a GIFT strain Nile tilapia that is better performing than the existing farmed Asian tilapia strains (Eknath and Acosta 1998). Apart from GIFT, the other genetic improvement initiatives of the public sector institutions included the FAC-CLSU Fish Genetics Project which developed a faster-growing Nile tilapia strain (presently known as the FaST strain), and the collaborative project of FAC-CLSU and University of Wales Swansea Project for development of YY technology to produce genetically all-male tilapias (GMT).

Development of collaborations with private sector

When donor support to genetic research programs (FAC-CLSU Fish Genetics Project, Genetic Manipulation of Farmed Tilapia and GIFT Projects) came to an end in 1996 and 1997, public sector institutions were faced with the challenge of finding ways of generating resources to continue the breeding research and to disseminate the products to end-users.

In the case of GIFT, a nonprofit private foundation was created in 1997 to continue the breeding research and disseminate commercially the improved fish. To generate resources for such activities, the foundation, through licensing arrangements, formed alliances with the private sector hatcheries in seed production, distribution and technology transfer to farmers and other industry development activities (Anon. 1997; Rodriguez 2002). Until 1998, the GFII was composed mainly of accredited private tilapia seed producers as main partners. However, in view of its growing needs of improving its financial capability, expanding market for its products and gaining access to more advanced selective breeding research, the foundation in 1999 established a formal alliance with GenoMar, a private sector Norwegian biotechnological company. This alliance enabled GenoMar to gain access to the established infrastructure and competencies of GFII which included the technology developed in the GIFT project, the improved tilapia strain, trained project staff, breeding facilities and a network of private sector tilapia hatcheries and growout farmers. The alliance between GFII and GenoMar marked a new phase in the production and dissemination of GIFT tilapia seed.

Effects of changing partnerships on genetic R&D activities

Research focus and priorities

In agricultural research, differences in the nature of research of public and private sector have been observed specifically in plant breeding. For example, research centers of the United States DA concentrate mostly on long-term breeding activities, while the private sector devotes most of its resources to short-term varietal development (Klotz-Ingram and Day-Rubenstein 2003).

In the case of fish, early research of public sector institutions on genetic improvement dealt initially with the strain and species crosses (interspecific and intergeneric hybridization). However, in view of the growing needs of the tilapia industry, the mid-1980s saw the shift in focus for short-term gains to long-term selective breeding programs and application of other genetic improvement technologies (for example, the chromosomal manipulation and hybridization).

Genetic improvement research of public sector institutions during the GIFT phase and the private sector collaboration involving GFII and GenoMar focused on selective breeding of Nile tilapias. While the public sector phase of collaborations (the GIFT Project) focused on traditional selective breeding for growth and sexual maturation, selective breeding program in the private sector collaboration phase (i.e., when GenoMar took over the breeding operations in 1999) was altered slightly using DNA genotyping technology to generate genetic maps or information that can be utilized in selecting for traits, which are difficult to record by traditional schemes (e.g., feed conversion ratio and disease resistance) (Gjoen 2001).

The present study revealed that differences in the goals and priorities of public and private sector institutions could also lead to differences in the focus on clientele farmers during the public sector phase (GIFT) and the private sector phase (GenoMar-GFII) of collaboration. Since there are more opportunities for greater volume of sales and commercialization, the private sector as exemplified by the collaboration between GFII and GenoMar focused more on medium to large-scale farmers as their clients rather than on the small, subsistence and resource-poor farmers. As a consequence of this, the collaboration between GFII and GenoMar put greater emphasis in examining traits that were more relevant to the medium and large-scale farmers (e.g., selection traits for high input and optimal environments).

Genetic research outputs

In the case of public sector research on GIFT, the main products of research are the improved Nile tilapia known as the GIFT strain and the development of genetic improvement methods that could be adopted for other tropical finfish. At the expiration of the GIFT Project in 1997, the GIFT strain family materials from the last selective breeding experiment (Generation 9) were provided to institutional partners of the GIFT Project. Since these outputs were developed using public funds and in view of the mandate of public sector institutions that received the GIFT strain, these family materials have been utilized primarily for noncommercial purposes – for genetic improvement research of public sector breeding programs. Also, through the International Network on Genetics in Aquaculture (INGA), being coordinated by the WorldFish Center, the strain has been made freely available to developing countries for aquaculture and/ or for developing their tilapia breeding programs (Gupta and Acosta 2001).

In Philippines, as a result of the agreement among public sector institutions that participated in the GIFT Project, GFII received the family materials of the GIFT strain and obtained the exclusive rights for commercial dissemination of the strain in the country. In 1999, in view of its formal agreement with GenoMar to secure long-term continuation of GIFT breeding initiative, GFII discontinued the commercial dissemination of the GIFT strain (Generation 10) in the country to give way to commercial dissemination of the further improved GIFT strain (the GenoMar Supreme Tilapia) produced from its collaboration with GenoMar.

GenoMar, on the other hand, obtained the exclusive commercial rights to all products emanating from its agreement with GFII, which include dissemination of the GenoMar Supreme Tilapia developed from Generation 10 GIFT strain (Rodriguez, pers. comm.).

Dissemination of improved strains and other research products

In the case of tilapias, the seed distribution system often consists only of either the private sector or the public sector. However, recently, in view of the significant progress made in genetic improvement and development of improved tilapia strains, advancements in farming technology and increased domestic and global demand for tilapias, the private sector (commercial local tilapia hatcheries[b]) has become increasingly involved, either solely or in collaboration, in production and dissemination of improved tilapia strains.

All institutions in Philippines involved in tilapia breeding involve the private sector in the dissemination of genetically improved seedstock. Under most partnership arrangements established for the distribution of seedstock, private sector partners remain uninvolved in actual genetic improvement R&D. The collaboration between GFII and GenoMar ASA is the only example of collaboration where the private sector partner is directly involved in the actual R&D activities.

Involvement of the private sector in dissemination helps provide the link that could facilitate the faster transfer of research products to end-users. However, there are also issues and concerns that might influence the efficiency and effectivity in the delivery of and accessibility to these products as a consequence of changes in nature of partnerships. The products referred to in the following sections are the broodstock for hatchery operations and fry or fingerlings for growout of the four improved tilapia strains that are being disseminated to end-users (GIFT/GST, GET/EXCEL, YY/GMT, and FAST).

Dissemination pathway

The GET/EXCEL, YY/GMT and FaST strains are being distributed through partnerships between public sector institutions and the private sector (private sector hatcheries). Among the strains, only the GIFT/GST is privately owned and is being distributed through an entirely private sector collaboration (Table 1). In general, the main actors at play in the entire dissemination process are the primary multipliers (breeding nucleus), secondary multipliers (private or government-owned hatcheries) and growout farmers. The breeding nucleus or primary multipliers are the main source of latest generation of improved strain and are responsible for maintaining the genetic integrity of these stocks. They produce the latest generation breeders and distribute these to the second-level private or government-owned hatcheries. These second-level hatcheries multiply or mass produce the stocks and disseminate the fingerlings to growout farmers (end-users). Depending on collaboration arrangements, the breeding nucleus may also distribute the improved fingerlings directly to growout farmers.

Improved strains from the primary multipliers (breeding nucleus) can either be openly accessed by users (i.e., without acquisition requirements) or can be accessed only through arrangements whereby the recipient of fish has to abide by some terms of agreement (e.g., licensing, accreditation or certification). Among different improved strains, only FAST could be obtained through open access as shown in Table 1.

The breeding nucleus for GIFT/GST, GET-EXCEL and YY/GMT produce and distribute both broodstock for hatchery operation and fry/fingerlings for growout farming. Only FAST is distributed from the breeding nucleus as broodstock, indicating that the product developers or breeding nucleus also deal directly with the ultimate users of the improved fish by distributing or marketing fish for growout operation.

Table 1. Mode of access of tilapia genetics-based fish products being distributed by breeding institutions under TSC (modified from Sevilleja 2004).

Improved tilapia (commercial/ popular name)	Breeding nucleus ownership	Year when distribution started	Distribution partnership	Mode of access	
				Broodstock	Fish for growout
GIFT/GST	Private	1998	Private	Licensing	Open
GET/Excel	Public	2000	Public-private	Certification	Open
YY male and XX broodstock and GMT	Public	1995	Public-private	Accreditation	Open
FAST*	Public	1993	Public-private	Open	Open

* This fish was initially distributed as IDRC-selected tilapia. It was renamed as FAST in 1998 and distributed only as broodstock.

[b] The Philippine DA (2002) estimated that there are more than 1,000 small-scale and large-scale private tilapia hatcheries operating throughout the country to fill the need for fingerlings.

Recipients of improved tilapia strains

Identification of users or recipients of the products of tilapia genetics research can provide a useful indication of whether a particular group of farmers is being favorably benefited compared to others in dissemination. Results of the study indicate that there is little difference in the age and experience of users (hatchery and growout farmers) of improved strains owned and produced by private and public sectors. Tilapia farmers using improved strains are on average 44 years of age and have been engaged in tilapia farming for 9 years with hatchery farmers having been in the business longer than the growout farmers. In general, the level of education of farmers is relatively high with majority having gone through college education. Among hatchery farmers, those using the improved strain from private sector collaboration (GIFT/GST) have the highest level of education.

Results also indicate that although tilapia farming is mainly dominated by men, 11% of all the respondents for both hatchery operators and growout farmers are women. Women's participation in tilapia farming is more evident in the production and multiplication of seed (hatchery) produced by an entirely private sector collaboration. For instance, 33% of the respondents involved in hatchery operation of the GIFT strain are women compared to only 6% involved in the hatchery operation of the government-owned GET-EXCEL strain (Table 2).

Since production is highly correlated to ownership and landholding, the other areas investigated by the project were the amount of land each respondent owns and his/her level of capital investment. Among respondents involved in hatchery operation, the users of the GIFT strain from the private sector collaboration own an average total land area of 10.53 ha, bigger than any of the land owned by users of other strains. On the other hand, among the growout farmers, users of the FAST strain owned by the public sector have the biggest landholdings (average total land area is 6.84 ha). In terms of capital investment, growout farmers using the GIFT strain has relatively lower level of investment (PhP166,369[c]/ha) compared to the same category of farmers using some of the publicly owned strains (e.g., PhP253,340/ha for GET-EXCEL users). However, among respondents involved in hatchery operation, those who are using the privately owned GIFT-GST strain have higher investments (PhP2,995,413/ha) than respondents using strains from the public sector.

Sevilleja (this vol.) noted that although majority of users of genetically improved tilapias are small landowners, these farmers are financially capable since they have ready access to capital from their own sources. Among farmers involved in hatchery operation, those with relatively higher level of education, investment and area of land owned tend to be in a better position to receive the benefits of genetics-based technology from private sector collaboration (i.e., GIFT-GST). These results suggest that dissemination mechanism, which specifically targets the "small and poor" tilapia farmers, is lacking.

Accessibility to improved strains

Accessibility to products of genetic improvement research (improved strains and technologies related to their production/farming) among users of improved tilapia strains was evaluated through analysis of sources of improved stocks (availability, price and level of satisfaction of users), tilapia farming knowledge and users' access to such information.

Results indicate that in general, majority of respondents (growout farmers and hatchery operators) obtain their stocks from the same source, and that the supply is available anytime when needed (see Sevilleja, this vol). This response is more evident among farmers involved in hatchery operation of GIFT strain, where the number of farmers who gave an affirmative answer was higher (100%) than the same group of farmers using any of the strains owned by the public sector. However, most farmers (90%) using the public sector GET-EXCEL strain were satisfied with the price paid for their stocks. Among growout farmers, users of GET-EXCEL (98%) and GIFT strain (84%) respectively gave the highest and lowest levels of satisfaction in terms of fingerling price.

Results also showed that users can access technologies relevant to farming of improved strains from several sources, including trainings and seminars, self-study, through friends and fellow farmers. Hatchery and

Table 2. Users of genetically improved tilapia strain by gender.

Gender	Growout (% of farmers)					Hatchery (% of farmers)				
	GIFT	GET/ EXCEL	GMT	FAST	All strains	GIFT	GET/ EXCEL	YY	FAST	All strains
Male	88	82	94	90	88.5	67	94	100	71	89
Female	12	18	6	10	11.5	33	6	0	29	11

Source: Sevilleja (2004).

[c] In January 2004, the average conversion rate was US$1 = PhP55.

pond-growout farmers had the training programs or seminars as their main sources of information. The study also found very little difference in the response of hatchery farmers using public and private sector-owned strains (for example, GIFT and GET-EXCEL). Sevilleja (2004) indicated that this is due to technical services being provided regularly by the public sector breeding nucleus and the training that is required for hatchery farmers to become accredited or certified users of improved strains from both public and private sector collaborations.

Concerning effectiveness of existing delivery systems and the services of extension agents, results showed that majority of farms (65-90%) received technical advice from suppliers of improved strain (private or public) and only about 30-68% of the farmers were visited by external technicians or consultants (Sevilleja, this vol.). This validates the finding that extension workers have not been fully utilized by farmers as source of knowledge on farming.

In the case of GIFT users who are involved in hatchery operation, all respondents (100%) indicated that source of technical advice is mainly from their resident technicians and partly from external technicians and suppliers of the improved strains. In contrast, growout farmers using the GIFT strain received their technical advice mainly from suppliers of improved strain (84%) and less from external technicians (30%). Concerning whether there is a difference in accessibility of technical information during the public sector phase of collaboration on GIFT and the present phase involving alliance with GenoMar, majority (83%) of the accredited hatchery farmers interviewed claimed that more focus is now being given on monitoring of production and sales of fingerlings and less on providing services to address the farmers' technical needs (Acosta and Gupta 2004).

The above findings confirmed earlier reports that tilapia farmers, especially growout farmers and smaller producers, are in need of more technical support and training. Rodriguez (2002) indicated that larger producers seem to have more access to technology and have taken the initiative to conduct their own inquiries. Results of the present study also indicated that fish breeding, nutrition, fish health and water quality are the broad areas where farmers need technical assistance.

Based on the foregoing, it is apparent that poor delivery of technical information especially to farmers involved in growout operation is the result of lack of coordination between private and government sectors. The Philippine DA (2002) confirmed that linkages among research institutions, local government units and fishfarmers are generally weak. Sevilleja (2004) emphasized the important role that farmers and private sector producers can play in the delivery of technical information. In view of their direct participation in the distribution of improved tilapia strains, they could be harnessed as strategic partners in the dissemination process.

Level of funding/expenditures for tilapia R&D by public and private sector institutions

Resources generation

Institutions involved in tilapia genetic research in Philippines generated resources through grants or allocation of government operating budgets and indirectly through commercial activities (i.e., selling seedstock) and entering into partnership arrangements with the private sector through new entities organized for the purpose (Rodriguez 2004). Unlike the public sector institutions where funding is mainly through their institutional budget allocations, the private sector breeding programs (i.e., GFII and GenoMar ASA) largely depended on sales and other related revenues. The GFII, due to its legal entity that is distinct from public sector institutions, is able to enter into arrangements or agreements with private entities to generate resources for R&D. Through its agreement with GenoMar on contracted research, GFII received funds to cover the costs of breeding activities in Philippines, including the planning and analysis of data in Norway. Rodriguez (2004) reported that although GFII has this relationship with GenoMar, it also maintains its own independent breeding nucleus and conducts R&D using the resources that GFII generates from its other activities.

Partnerships and their impact on level of funding and expenses for R&D

Partnerships between the institutions involved in breeding and the private sector in the dissemination of improved seedstock provided the former with the business opportunities to generate resources for R&D. These partnerships between private and public sectors utilize models that included direct broodstock sales, accreditation programs and licensing agreements and are based on the use by private hatchery operators of broodstocks provided by the breeding institutes in the production of seedstock for sale.

The levels of expenditures of public sector institutions are largely influenced by grants and institutional budget allocations they received, while the private sector breeding programs, by revenues generated from commercial activities. The revenues generated and genetic research expenditures during 1998-2002 for GFII ranged from PhP9.92 million to PhP16.91 million and from PhP9.43 million to PhP16.52 million, respectively. Annual expenditures on genetic research of public sector institutions ranged from PhP0.07 million to PhP10.96 million, depending on annual operational budget (Table 3).

Table 3. Operating revenues and R&D expenditures, in PhP million, of a nonprofit private sector (GFII).

Year	Revenues*	Expenditures**	Expenditures (as % of revenue)
1998	9.9	11.3	113.7
1999	10.0	9.4	94.8
2000	12.6	3.1	104.1
2001	15.0	12.7	84.6
2002	16.9	16.5	97.7

Source: Modified from Rodriguez (2004).
* Primarily from fingerling sales and fees earned from GFII's hatchery licensing program.
**Represent expenses incurred by GFII on personnel, supplies and services, travel, depreciation.

Results indicate that all breeding institutions under TSC, with the exception of GFII, did not have systems to track and monitor investments in genetic research. The absence of financial information and values may contribute to difficulties in negotiating public-private partnerships in R&D and in commercialization of research outputs.

Issues that Need to be Addressed

The programs for tilapia genetic improvement in Philippines have undergone transformations and changes that have influenced various players whose roles have evolved over time. The experience of breeding institutions under TSC as they approach commercialization of the outputs of research (improved strains of tilapia) has revealed important lessons not only for the Philippine tilapia industry but also for other developing countries that are in the same stage of growth or are anticipating more private sector involvement in their breeding programs.

Increase public sector capacity for legal partnership with private sector

Public sector institutions that are now commercializing their products of genetic research lack the capacity in engaging the participation of the private sector. The public sector institutions entering partnership agreement with the private sector should have the capacity for legal arrangements, particularly in the management of intellectual property rights (IPR). In view of the complexity of matters and issues that relate to ownership of improved germplasm, it is essential that public sector institutions entering into alliance with the private sector seek expert advice on IPR issues. Of particular significance are the issues that relate to protection of breeders' rights and ensuring that partnership arrangements will not restrict the breeding institutions to perform functions that will bring benefits to the poor.

Institute a follow-up program for improved strains

The government or public sector institutions play an important role in providing the technical support needed to enable the breeding program to achieve its goals. A followup program should be planned and implemented once improved strains have been developed and disseminated. While control of a central genetic nucleus remains in the public sector, a dedicated competent human support service has to be made available to oversee and instigate the gradual involvement of the private sector in the program for reproduction and commercial dissemination of the improved strain (Ponzoni, pers. comm.).

Public sector institutions must also define and institute a mechanism that will provide funds to fill the gap during the period when external support ends until such time a new source of fund is identified and a strategy for continuing the breeding program has become operational.

Define the roles of public and private sectors

Most of the concerns and issues that emerged in the project are due in part to lack of clarity of roles of public and private sector institutions engaged in the program for genetic improvement of tilapia and dissemination of research outputs. Effective partnerships of public and private sectors can only be facilitated if roles of the various players are clear and agreed upon by everyone. The stakeholder workshops organized by the project recommended that public and private sector institutions in the country should work together for effective delivery of improved tilapias and technology to end-users. These workshops also assessed and identified the roles of the various players in the overall program for genetic improvement and dissemination of the improved strains.

Foster an "enabling environment" for public-private sector partnership

The growing involvement of the private sector in the breeding and dissemination program for improved tilapias in Philippines underscores the need to identify strategies that will enhance partnerships between public and private sectors for mutual achievement of their objectives. A major challenge is for both private and public sectors to find ways on how best to collaborate in transferring the products of genetic improvement research and provide benefits to a larger section of the society.
Support programs and policies that will create an enabling environment for partnerships in the dissemination and commercialization of genetic research outputs are still lacking. Support programs, clearly spelt-out policies, institutional mechanisms and frameworks must be put in place to pave the way for strategic partnerships between public and private

sectors. The present project, for example, has identified that similar to crops, private sector companies will only be encouraged to invest in commercializing research products developed by public sector breeding institutions if policies (e.g., protective technology or seed certification) guaranteeing proprietary protection are developed. Public sector institutions must also have established policies that will specify the conditions under which they should collaborate with the private sector.

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References

Abella, T. 2004. Role of public sector in genetics research and its partnership with private sector. Paper presented during the Workshop on Public-private Partnerships in Tilapia Genetics and Dissemination of Research Outputs, 21-23 January 2004, Tagaytay City, Philippines.

Acosta, B.O. and M.V. Gupta 2004. Public-private Partnerships for Tilapia Genetics Research in Philippines: Case Study on GIFT and Lessons Learned. Paper presented during the Workshop on Public-private Partnerships in Tilapia Genetics and Dissemination of Research Outputs, 21-23 January 2004, Tagaytay City, Philippines.

ADB. (Asian Development Bank). 2006. Policy on fisheries: IV. The issues: challenges and opportunities. [Retrieved 2 March 2006 from http://www.adb.org/ Document/ Policies/ Fisheries/ Fish440.aspp=Policies].

Anon. 1997. GIFT Foundation International Inc. Strategic plan. 8 p. (Unpublished).

BFAR (Bureau of Fisheries and Aquatic Resources). 2006. The Philippine Bureau of Fisheries and Aquatic Resources: overview. Paper presented at the WorldFish Center and Philippine Partners Meeting, 28 February 2006, Quezon City, Philippines. (Unpublished).

DA (Department of Agriculture). 2002. A master plan for the tilapia industry of the Philippines.

Eknath, A.E. and B.O. Acosta. 1998. Genetic Improvement of Farmed Tilapia Project final report (1988-1997). ICLARM, Manila, Philippines. 75 p.

Gjoen, H. 2001. GIFT program continues: distribution of fast-growing tilapia to expand. Advocate (December).

Gupta, M.V. and B.O. Acosta. 2001. Networking in aquaculture genetics research, p.1-5. *In* M.V. Gupta and B.O. Acosta (eds.) Fish genetics research in member countries and institutions at the International Network on Genetics in Aquaculture. ICLARM Conf. Proc. 64, 179 p.

Klotz-Ingram, C. and K. Day-Rubenstein. 2003. The changing agricultural research environment: what does it mean for public-private innovation? AgBioForum 2(1). [Retrieved from: http://www.agbioforum.org/v2nl/v2m1a05- klotz.com].

Lopez, N., J.O. Dickson and R.V. Ramiscal. 2005. Trends and patterns in Philippine fisheries, p. 3-13. *In* Y.T. Garcia, M.M. Dey and R.L. Tan (eds.) Sustaining fisheries and aquaculture production to benefit poor households in the Philippines. 311 p.

Macaranas, J.M., N. Taniguchi, M.J.R. Pante, J.B. Capili and R.S.V. Pullin 1986. Electrophoretic evidence of extensive hybrid gene introgression into commercial *Oreochromis niloticus* (L.) stocks in the Philippines. Aquacult. Fish. Manage. 17: 248-258.

Pinstrup-Andersen, P., R. Pandya-Lorch and M.W. Rosegrant. 1999. World food prospects: critical issues for the early twenty-first century. Food policy report: 2020 vision.

Pullin, R.S.V., Editor. 1988. Tilapia genetic resources for aquaculture. ICLARM Conf. Proc. 16, 108 p. International Center for Living Aquatic Resources Management, Manila, Philippines.

Pullin, R.S.V. and J.B. Capili. 1988. Genetic improvement of tilapias: problems and prospects, p. 259-266. In R.S.V. Pullin, T. Bhukaswan, K. Tonguthai and J.L. Maclean (eds,) The Second International Symposium on Tilapia in Aquaculture. ICLARM Conf. Proc. 15, 623 p.

Rodriguez, B.M. 2002. Dissemination strategies for GIFT. Paper presented at the International Network on Genetics in Aquaculture Meeting in Thailand.

Rodriguez, B.M. 2004. Generating resources to continue tilapia genetic improvement R&D through public-private sector partnerships in the Philippines. Paper presented during the Workshop on Public-private Partnerships in Tilapia Genetics and Dissemination of Research Outputs, 21-23 January 2004, Tagaytay City, Philippines.

Sevilleja, R.C. 2004. Effects of evolving partnerships on access to and uptake of tilapia genetic improvement technologies and their products: results of survey and policy implications. Paper presented during the Workshop on Public-private Partnerships in Tilapia Genetics and Dissemination of Research Outputs, 21-23 January 2004, Tagaytay City, Philippines.

Role of Public Sector in Genetics Research and Its Partnership with Private Sector in the Philippines

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Abstract

The many years of genetics research implemented by the public sector has significantly contributed to the increased production of tilapia in Philippines. The implementation of the various genetics projects was made possible through joint collaboration among government institutions and agencies and international organizations with funding from both national and international donor agencies. Although funding for the various genetic projects has ended, continuation of the selection program activities is sustained through different modes of financial support and foremost among these is partnering with the private sector. The partnership of public and private sectors in pursuing a long-term genetic program for tilapia has shown its important role in the development of genetically improved tilapia as supported by state policies for a sustained genetics research in Philippines.

Introduction

The remarkable contribution of tilapia production to Philippine aquaculture is well recognized. This resulted in an increase of the aquaculture sector's share to total Philippine fish production of 3.96 million t in 2004 (BFAR 2005). The total tilapia production in the same year was registered at 145,868 t which is a far cry from the early years of tilapia growout operations in the country where the industry's growth was hampered by questionable genetic integrity of fish stocks and by limited availability of fingerlings to fish farmers (Abella 1989). Apart from the good seeds that are available now, the increase in production of this aquaculture commodity can be attributed to good management practices and increase in the number of growout operators.

For the past 20 years, public sector institutions have been actively involved in genetics research in tilapia with the aim of addressing the immediate concern of the industry which is supply of good quality fingerlings and breeders.

Enabling Environment for Fish Genetics R&D

State policies and relevant legislation

The 1987 Philippine Constitution recognizes the responsibility of the state in the protection, development, management and conservation of fishery and other aquatic resources. It mandates that the state shall provide support through appropriate technology and research, adequate financial, production and marketing assistance and other services.

In fisheries research, the goal is to improve the quality of life of fishfarmers or fisherfolk by developing improved and more efficient technology and to increase the country's global competitiveness in the production of fish and other aquatic products through such advancements. The attainment of these goals is stressed and supported in various government policies and legislations, which also justify the continuous work in fish genetics research. Specifically, Section 80 of Republic Act 8435 (Agriculture and Fisheries Modernization Act) of 1997, states that it is the policy of the state to promote science and technology as essential for national development and progress (DA 1998). Section 82 of the Philippine Fisheries Code of 1998 also provides for the creation of a National Fisheries Research and Development Institute and one of its objectives is to raise the income of the fisherfolk and to elevate Philippines among the top five in the world ranking in fish production (DA-BFAR 1998).

Under the National Integrated Research Development and Extension Program (Aquaculture) and in the formulation of the Aquaculture Research Development and Extension agenda of the Department of Agriculture (DA)-Bureau of Agricultural Research (BAR) and the Philippine Council for Aquatic and Marine Research Development, one of the areas that should be addressed is the development of improved strains and new species for aquaculture through genetics and biotechnology. This development is aimed to make the aquaculture industry profitable and sustainable (DA-BAR 2001).

Under these policies and legislations, it is clear that the government has given impetus to the continuous development of quality seeds of aquaculture species particularly the Nile tilapia. The government should see to it that its commitment to support a long-term genetics program in aquaculture requires substantial financial support and dedication among the major institutions engaged in this genetics research endeavor.

Research and development

The public sector has been a major player in the implementation of tilapia genetics research in Philippines, which started in the late 1970s (Kuo and Abella 1982). There was an urgency to embark in this kind of research because of the growing concern of the industry years ago of the deteriorating quality of tilapia broodstocks. Table 1 shows the different genetic research projects that were conducted and are being conducted to improve the performance of cultured tilapia. The implementation of the various projects was through joint collaboration among government institutions and agencies and international organizations with funding from both national and international donor agencies. This multi-institutional collaboration from the public sector has the following general objectives:

- to develop new superior breeds of fish by efficient artificial selection, hybridization and other genetic improvement procedures;
- to enhance the scientific capabilities of the cooperating institutions through formal training and cooperative research; and
- to develop improved broodstock management practices for farmers.

The early genetics work on the improvement of tilapia focused on strain and species crosses (Kuo and Abella 1982; Abella 1989; Recometa 1989). The mid-1980s saw the shift from the plain crosses to an organized selection program (Abella et al. 1990; Eknath et al. 1993; Mair and Abella 1997; Pullin 1998; Camacho et al. 2001). The goal was to produce breeds of tilapia that will perform well in various culture environments. While the focal interest in the various genetic research projects was on the growth trait characteristic of the fish, new genetic projects are also looking at the selection of salinity-tolerant tilapia and other traits of economic importance (DA-BAR 2001).

Sustainability of the Tilapia Genetics Research

With the termination of the three donor-funded major genetic research projects almost at the same time – the FAC-CLSU Fish Genetics Project in 1996, the GMIT and the GIFT Projects in 1997 – the problem that has cropped up was how the national institutions could continue the selection and research and related activities. In the case of the Fish Genetics Project, the host institution, FAC, continued its selection work by engaging technical staff previously working with the project to be fully in-charge of the day-to-day operation of the project. Income generated from the sale of FAC Selected Tilapia (FaST) fish is plowed-back to the various activities of the project. This scheme is possible because of the autonomy given to state universities to use its own income for purposes of research, extension and production activities as stipulated in Section 4 of Republic Act 8292 (Congress of the Philippines 1998).

Although BFAR was also a collaborator in the GMIT Project, it was not able to extend much of its assistance in the dissemination of research products of the project because it has already committed itself to GIFT in the dissemination phase. An alternative mechanism for dissemination was conceived which included an important component of income generation to support dissemination and research activities (Clarke et al. 1998). Under approval from its Board of Regents, CLSU through FAC established the Phil-Fishgen as an income-generating project. It has the dual objective of disseminating the products of the research on the YY-male technology and generating income to support research and dissemination activities. As a nonprofit organization, the net income of Phil-Fishgen for each calendar year is distributed as shown in Table 2.

Although the Phil-Fishgen is in CLSU, its operation is on a private-like manner. Another good development that happened in the GMIT Project was the institutionalization of its key personnel that insured smooth transition when it ended in 1997. This was made possible because of the strong support and recognition of the university administration to the project's role in attaining the vision and mission of the university and its impact to tilapia industry. This is a case of strong public sector support to genetics research.

Distribution of the Products of Genetics Research

While the ultimate objective of embarking on genetic research was to help small farmers, majority of the beneficiaries belong to the higher strata of socioeconomic standing. Small farmers cannot avail of the improved broodstocks to produce their own fingerlings except for the GET-EXCEL and FaST which do not impose strict requirements (Table 3).

A National Tilapia Broodstock Center (NBC) was envisioned to continue the selective program once the GIFT Project's financial support ended. The establishment of a National Broodstock Center was a strategic plan in the Recommendation and Consolidated Proposals on Tilapia Industry Development Program of 1993. The plan to institutionalize the GIFT Project did not happen because of the lack of financial

Table 1. Tilapia genetics research programs of public sector institutions.

Research Project	Year	Implementing institutions	Donor(s)	Significant Results
Genetic Improvement of Tilapia Broodstock	1979-1981	International Center for Living Aquatic Resources Management (ICLARM)/Freshwater Aquaculture Center-Central Luzon State University (FAC-CLSU)	Rockefeller Foundation (RF)	Evaluated existing stocks of tilapia in the country
Mass Production of Tilapia Fry	1980-1982	ICLARM/FAC-CLSU	RF, Agricultural Research Organization, Israel	Showed differences in culture performance between different tilapia species and hybrids
Genetic Improvement of Tilapia in the Philippines	1983-1985	FAC-CLSU	Philippine Council for Agricultural Resources and Research Development (PCARRD)	Evaluated different strains of *Oreochromis niloticus*
Genetic Characteristics of Food Fishes	1983-1984	University of the Philippines-Marine Science Institute (UPMSI)	ICLARM (now WorldFish Center)	Showed poor status of Asian *Oreochromis niloticus* stocks and hybridization with O. *mossambicus*
Evaluation of Farmed Tilapia Stock	1984-1988	UPMSI, University of Houston-Clear Lake, FAC-CLSU	United States Agency for International Development, International Development Research Centre (IDRC), PCARRD	Confirmed poor status of Philippine O. *niloticus* stocks and that breeders and farmers want quality fish; improved electrophoretic methods
Fish Genetics Project	1986-1996	FAC-CLSU	IDRC	Produced fast-growing strains of O. *niloticus*
Genetic Manipulation for the Improvement of Tilapias	1988-1997	University of Wales, Swansea/FAC-CLSU, BFAR-National Freshwater Fisheries Technology Center (NFFTC)	Overseas Development Administration (ODA)	Produced genetically male tilapia for growout and YY breeders for fingerling production
Genetic Improvement of Farmed Tilapia	1988-1997	Institute of Aquaculture Research (AKVAFORSK), Norway, FAC-CLSU, ICLARM, BFAR-NFFTC, UPMSI	Asian Development Bank and United Nations Development Programme	Produced fast-growing strains of *O. niloticus* and demonstrated that *O. niloticus* did respond positively to selection
Development of Saline-tolerant Tilapia	1998-present	FAC-CLSU, BFAR-NFFTC, University of the Philippines in the Visayas	DA-BAR	Formed a base population from four different *Oreochromis* species by combining best performing purebreds and crossbreeds after rigid evaluation in different environments
Development of Saline Tilapia Strains (*Molobicus*)	-	BFAR-National Integrated Fisheries Technology Development Center (BFAR-NIFTDC)	Philippine Council for Aquatic Marine Resources and Development (PCAMRD) and Centre de Coopération Internationale en Recherche Agronomique pour le Développement	Developed saline tilapia hybrids through hybridization using *O. niloticus* and *O. mossambicus*
Genetic Enhancement of Nile Tilapia	2001-present	WorldFish Center/FAC-CLSU, FishGen Ltd.	Department for International Development	

Table 2. Distribution of net income generated by Phil-Fishgen.

Beneficiary	Proportion (%)	Notes
DFID Fish Genetics Programme	50	Funds generated have already been used for research
Collaborating institutions	20	Acquisition of equipment for research and instruction
Dissemination fund	15	Used for promotion of technology targeting small-scale farmers
Staff incentive	13	Used for productivity incentive
Reserve	2	

Table 3. Products of genetic research and their intended beneficiaries.

Product(s)	Beneficiaries
Technology	
GIFT	Academic institutions, government agencies, private individuals
YY-male	Academic institutions, government agencies, private individuals
FaST	Academic institutions, government agencies, private individuals
GET-EXCEL	Academic institutions, government agencies, private individuals
Fingerlings	
GIFT	Growout operators, academic institutions
GMT	Growout operators, academic institutions
GET EXCEL	Growout operators, academic institutions, government agencies
Broodstock	
GIFT	Accredited hatcheries
YY-male producing broodstock	Lead national hatcheries, breeding centers
GMT-producing broodstock	Accredited hatcheries
GET EXCEL	Government and private hatcheries

commitment from the government. As a result of the failure to establish NBC, the creation of a foundation to continue the breeding program of the GIFT Project was suggested as an alternative to NBC; hence, the birth of the GIFT Foundation International, Inc. (GFII).

Partnering with the Private Sector

Although the bulk of activities of the previous and present fish genetics research is performed by the public sector, the role of the private sector cannot be ignored. The private sector was involved in the adaptive research phase during the performance evaluation trials of the genetically improved fish in different culture environments (Figure 1).

The establishment of the Tilapia Science Center (TSC) in the Science City of Muñoz with CLSU as the lead institution has opened up more avenues and opportunities for public and private partnership to conduct genetics research. The TSC is a consortium of agencies and institutions representing the academe (FAC/College of Fisheries), a government agency (NFFTC-BFAR), a nonprofit organization (GFII) and a business entity (Phil-Fishgen) which bonded together with a common vision and goal of developing the country's tilapia industry. The TSC, however, has yet to be registered with the Securities and Exchange Commission in order to acquire legal personality. The TSC is envisaged to have a stronger personality to source out more funds for genetics research especially from the private sector.

Conclusions

- The different genetics projects on tilapia have made significant contributions in elevating the tilapia industry to its present status.
- Tilapia farmers now have many genetically improved tilapias to choose from.
- The public sector institutions that were involved in the various research projects were able to continue selection work although under modest financial resources.

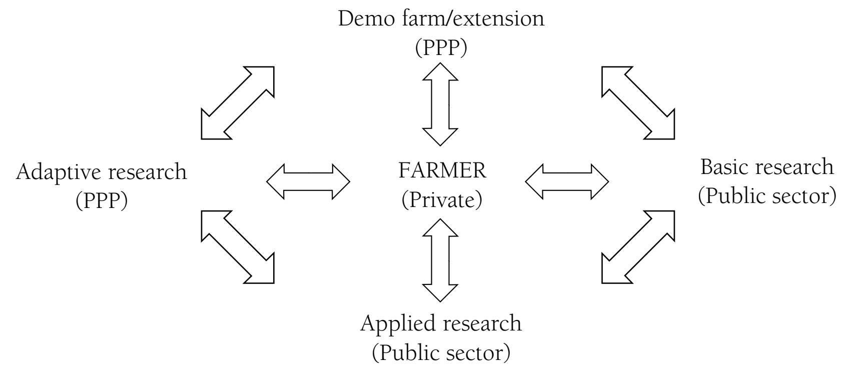

Figure 1. Genetics research flow.

Recommendations

- Most of the genetic researches conducted were joint collaborations between government academic institutions and agencies. Among these researches were generations of genetics-based technologies for the aquaculture industry. When a breed of tilapia is produced from one genetics project and is used to develop a new breed, a question is raised on the propriety of this product. This relates to the issue of intellecual property rights. Suitable systems and methods for protection of any intellectual property by law of patents, design and copyrights should be instituted at the right time (i.e., even from the very early stage of initiation of the research and development project).

- The public sector, with its financial resources decreasing, should make new alliances and partnerships with private sector to ensure continuing system and sustained budget for genetics research.

- Linkages should be established with international R&D institutions.

References

Abella, T.A. 1989. Evaluation of tilapia strains and hybrids for land-based systems, p. 38-41. *In* L.C. Darvin, D.L. De Guzman and R.B. Baguilat (eds.) Tilapia genetics and culture. Proceedings of the Seminar Workshop on Tilapia Genetics Culture, 20-22 June 1985, Freshwater Aquaculture Center, Central Luzon State University, Nueva Ecija, Philippines. Philippine Council for Aquatic and Marine Research and Development and International Center for Living Aquatic Resources Management Book Series No. 01/1989, 62 p.

Abella, T.A., M.S. Palada and G.F. Newkirk. 1990. Within family selection for growth rate with rotation mating in *Oreochromis niloticus*, p. 515-518. *In* R. Hirano and I. Hanyu (eds.) The Second Asian Fisheries Forum. Asian Fisheries Society, Manila, Philippines. 991 p.

BFAR (Bureau of Fisheries and Aquatic Resources). 2004. Philippine fisheries profile 2004. Bureau of Fisheries and Aquatic Resources, Department of Agriculture, Quezon City, Philippines. 62 p.

Camacho, A.S., T.A. Abella and M.M. Tayamen. 2001. Fish genetics research and development in the Philippines. p. 71-76. *In* M.V. Gupta and B.O. Acosta (eds.) Fish genetics research in member countries and institutions of the International Network on Genetics in Aquaculture. ICLARM Conf. Proc. 64, 179 p.

Clarke, G., G. Mair, E. Morales, A. Black and R.C. Sevilleja. 1998. Small-scale farmers and genetics-based technology in Philippine aquaculture. Socio-economic analysis of the dissemination and impact of genetically male tilapia (GMT). Final Tech. Rep. R6937. Fish Genetics Research Programme, Department for International Development, London, UK.

Congress of the Philippines. 1996. Republic Act No. 8292. An Act Providing for the Uniform Composition and Powers of the Governing Boards, the Manner of Appointment and Term of Office of the President of Chartered State Universities and Colleges, and for other Purposes (Higher Education Modernization Act of 1997).

DA (Department of Agriculture). 1998. Implementing Rules and Regulation DA AO (1998). Pursuant to Republic Act 8435. The Agriculture and Fisheries Modernization Act of 1997.

DA-BAR (Department of Agriculture-Bureau of Agricultural Research). 2001. Strategic plan 2001-2005. DA-BAR, Quezon City, Philippines.

DA-BFAR (Department of Agriculture–Bureau of Fisheries and Aquatic Resources). 1998. Implementing Rules and Regulation (1998). Pursuant to Republic Act 8550. The Philippine Fisheries Code of 1998.

Eknath, A.E., M.M. Tayamen, M.S. Palada-de Vera, J.C. Danting, R.A. Reyes, E.E. Dionisio, J.B. Capili, H.L. Bolivar, A.V. Circa, H.B. Bentsen, B. Gjerde, T. Gjedrem and R.S.V. Pullin. 1993. Genetic improvement of farmed tilapias: the growth performance of eight strains of Oreochromis niloticus tested in different farm environments. Aquaculture 111: 171-188.

Kuo, C.M. and T.A. Abella. 1982. Genetic improvement of tilapia broodstock in the Philippines, p. 23-25. *In* J.L. Maclean (ed.) ICLARM Report 1981. International Center for Living Aquatic Resources Management, Manila, Philippines. pp. 23-25.

Mair, G.C. and T.A. Abella, Editors. 1997. Technoguide on the production of genetically male tilapia (GMT). Freshwater Aquaculture Center, Central Luzon State University, Nueva Ecija, Philippines.

Pullin, R.S.V., Editor. 1988. Tilapia genetic resources for aquaculture. ICLARM Conf. Proc. 16, 108 p.

Recometa, R.D. 1989. Tilapia genetics research at FAC: an overview, p. 3-6. *In* L.C. Darvin, D.L. De Guzman and R.B. Baguilat (eds.) Tilapia genetics and culture. Proceedings of the Seminar Workshop on Tilapia Genetics and Culture, 20-22 June 1985, Freshwater Aquaculture Center, Central Luzon State University, Nueva Ecija, Philippines. Philippine Council for Aquatic and Marine Research and Development and International Center for Living Aquatic Resources Management Book Series No. 01/1989, 62 p.

Role of Public Sector in Dissemination of Tilapia Genetic Research Outputs and Links with Private Sector

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Abstract

In Philippines, dissemination of improved tilapia strains is facilitated by the public sector through government institutions and agencies following different distribution mechanisms. The success of this product technology dissemination can be attributed to active participation of the private sector, making improved strains of tilapia more accessible to farmers through the establishment of accredited private hatchery farms. This paper presents the role of the public sector in the dissemination of products of genetics research, including issues and concerns associated with this activity.

Introduction

In the Philippine Fisheries Industry Plan for 1999-2004, aquaculture is seen as the "best bet" to increase fish production, and among the aquaculture products, tilapia is identified as the "most promising" (FIDC 1999). In tilapia farming, genetic improvement is identified as a strategic and priority activity. Over the last 25 years, the tilapia industry in the country has achieved tremendous progress. There is no doubt that one factor which contributed to the increased tilapia production over the last five years is the development and production of improved tilapia strains. Philippine tilapia farmers have now access to the different improved tilapia strains that are being disseminated through public and private sector partnerships. These improved strains are the Genetically Male Tilapia (GMT), FaST (FAC Selected Tilapia) and the Genetically Improved Farmed Tilapia (GIFT)-derived strains, namely, Genomar Supreme Tilapia (GST) and GET-EXCEL (EXcellent strain that has Competitive advantage with other tilapia strains for Entrepreneurial Livelihood projects in support of aquaculture for rural development).

Roles and Functions

The public sector represented by government agencies and research institutions play a very important role in the production and dissemination of improved tilapia strains. The leading government agencies responsible for this task are the National Freshwater Fisheries Technology Center of the Bureau of Fisheries and Aquatic Resources (NFFTC-BFAR) of the Department of Agriculture (DA), and the Freshwater Aquaculture Center of the Central Luzon State University (FAC-CLSU). These institutions perform specific roles and functions which are vital to the sustainability of a tilapia industry which relies significantly on genetics-based technology. These are enumerated and discussed in the following sections.

Maintenance of a breeding nucleus

As a breeding nucleus, the BFAR-NFFTC serves as the National Broodstock Center (NBC) for genetic management of tilapia to be multiplied and disseminated for aquaculture production. It also serves as depository of tilapia species and strains for maintenance of genetic diversity in the country. Another responsibility of the center is the distribution and monitoring of test strains among DA Regional Fishfarms and private hatchery cooperators. The center also undertakes market assistance and referral to private hatchery operators and assists in the evaluation of the central or satellite hatcheries.

In line with the above functions of BFAR-NFFTC as a breeding nucleus, it developed the BFAR GET- EXCEL tilapia using a selective breeding technique from founder stocks comprising four strains of *O. niloticus*

(GIFT, FaST, Egypt and Kenya). The new strain was developed based on the premise that replacing old tilapia breeds with the latest improved strain will bring about the targeted incremental production increase in the freshwater aquaculture sector. In view of this, the project "Nationwide Dissemination of GET EXCEL Tilapia" was launched by DA through BFAR. The project was implemented by BFAR-NFFTC, the Regional Outreach Stations-Central Hatcheries (ROS) of DA, and accredited private hatcheries which serve as multiplier stations making this strain more accessible to farmers.

The FAC-CLSU is the government institution responsible in the development of FaST through its collaboration with the International Development Research Centre (IDRC). The center was able to produce a fast-growing tilapia using a within family selection and starting from the available strains of *O. niloticus* (Bolivar et al. 1994). The center was also responsible in the development of GMT and GMT-producing broodstock through the application of the YY-male technology which was conceptualized as a method of generating monosex tilapia providing an alternative to hormonal sex reversal and hybridization (Mair et al. 1997). This technology was developed in collaboration with the School of Biological Sciences of the University of Wales Swansea (UWS), funded by a series of projects under the Department for International Development (DFID, formerly the Overseas Development Administration or ODA) Fish Genetics Programme based in United Kingdom.

Breeding and genetic improvement

As part of their function as breeding nucleus, NFFTC-BFAR and FAC-CLSU perform the sensitive task of conducting tilapia breeding and genetic improvement.

At present, this particular activity is performed only by government agencies which have the human resource and expertise, the facilities, and the mandate to develop and distribute improved tilapia to farmers. In addition to the objective of developing new improved strains of tilapia, this function is also intended to fine-tune the protocols for tilapia breeding and genetic improvement.

Research and development

FAC-CLSU is mandated to do both research and development (R&D) work. Its research activities related to tilapia genetics include the evaluation of the growth performance of improved strains of tilapia; development of appropriate cultural and management practices especially those related to stocking densities, feeding and fertilization; and on-farm testing. It also provides technical assistance to farmers in terms of finding solutions to their problems.

The main function of NFFTC-BFAR is to conduct activities that will redound to the overall development of freshwater aquaculture industry of the country. In line with this, it conducts training of farmers; implements a restocking program of freshwater lakes, rivers and reservoirs; and disperses fish seeds to farmers.

Production and distribution

This function is essential in making improved tilapia available to producers, especially the small farmers. Two models of production and distribution mechanisms are presented. One common feature is the significant role and participation of the private sector.

Figure 1 below shows the diagram of fish production and distribution of improved breeds of tilapia (GET-EXCEL) model being implemented by NFFTC-BFAR. In order to facilitate production and distribution, two levels of multipliers are accredited. These are the Central Hatcheries consisting of ROS of DA; provincial and other government hatcheries; and the Satellite Stations consisting of registered and certified private hatchery farms.

The ROS serve as Regional Broodstock Centers (RBCs). They are the main recipients of parent population from NBC. The main function of the Central Hatcheries is to mass-produce fingerlings following the recommended broodstock management system. which are then sold to accredited private hatcheries as parent tilapia stock. The RBCs also mass-produce fingerlings for growout operators and for stocking to communal bodies of water. In order to ensure that the fingerlings produced are properly distributed, RBCs are also engaged in market assistance and make referrals to private hatchery operators.

The registered or certified private hatcheries act as Satellite Multipliers of the Central Hatcheries. The main function of the satellite multipliers is the production of fingerlings for growout from the broodstock received from NBC or RBC.

The FAC-CLSU as a Breeding Center also developed its own distribution mechanism for GMT, GMT-producing broodstock (Figure 2). The primary objective of the center in developing the YY-male technology is anchored on a broader purpose of assessing the potential of GMT to contribute to the two-pronged thrust of the project on poverty reduction and improved food security. To accomplish these thrusts, the products of the projects must be disseminated and shared effectively to the target clientele, the farmers.

The production and distribution mechanism was devised under the auspices of a semi-autonomous "project" of CLSU known as Phil-Fishgen, established in 1985 with the approval of the CLSU Board of Regents, through its FAC. Phil-Fishgen is coordinated by a management committee including representatives from FAC/CLSU and the University of Wales Swansea,

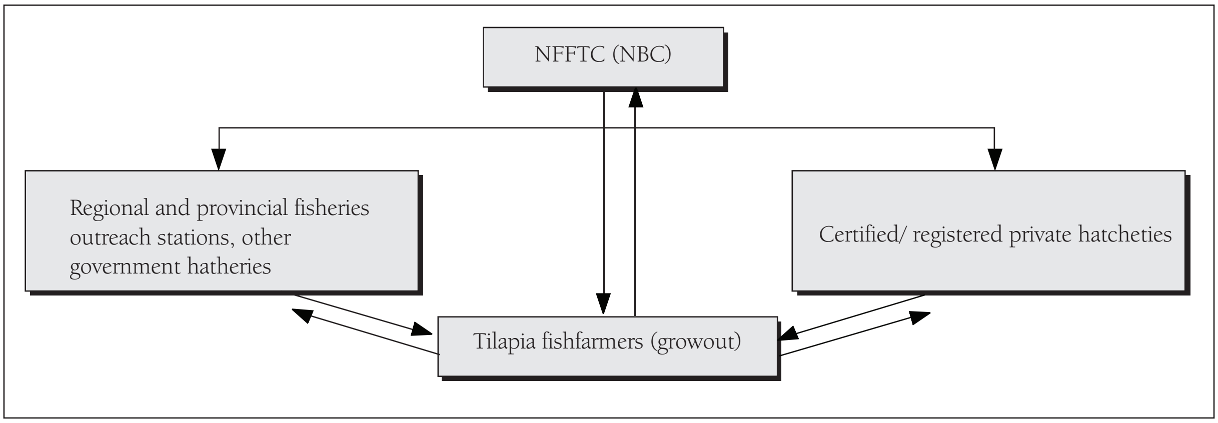

Figure 1. Diagram of the flow and distribution of improved tilapia from NFFTC.

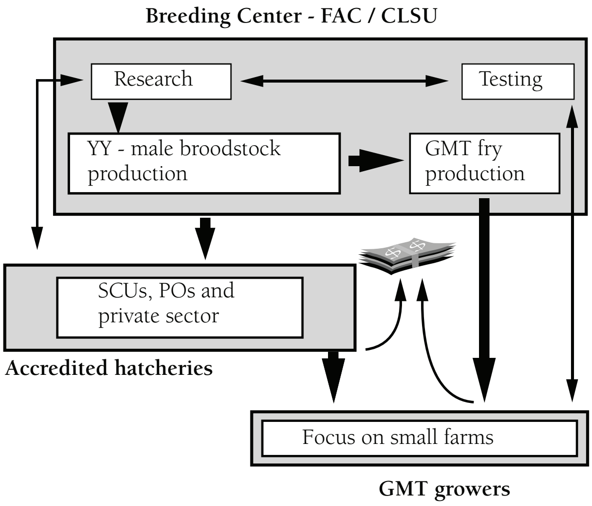

Figure 2. Structure of the dissemination network for GMT and GMT-producing broodstock under Phil-Fishgen.

but has its own staff including an operations manager responsible for day-to-day management. Phil-Fishgen functions as a nonprofit entity although it does generate surplus, which is allocated in support of R&D activities (Capili-Mair 1997). The structure and function of Phil-Fishgen are outlined in Figure 2. It disseminates the outputs of the technology under the registered trade name of GMT® under license from Fishgen Ltd. (UK).

Phil-Fishgen has the dual functions of disseminating the outputs of YY-male technology and generating income to support research and extension activities. Through this mechanism, products are disseminated in two ways: (1) through production and sale of GMT direct to farmers and (2) through production and distribution of GMT-producing broodstock (YY-males and normal XX-females) to a network of accredited hatcheries).

Under the dissemination scheme, a Breeding Center was established at FAC, which is responsible for continued research, development and evaluation of GMT, and for production of YY-male and normal female broodstock. GMT fingerlings are also produced in the center for direct distribution to farmers with medium-term production target of 1 million fingerlings per month, which was achieved in 2002. While direct sales of GMT is important for regular income generation, production of GMT-producing broodstock for distribution to accredited hatcheries is the most important activity of the center with regard to realizing the potential to have a significant impact upon the tilapia industry through widespread uptake of the technology (Mair et al. 2002).

Accreditation of hatcheries

Another function of the Breeding Centers is the accreditation of hatcheries, both public and private. This aspect of the production and distribution process is very vital in order to ensure the integrity and quality of the improved tilapia.

For the NFFTC-BFAR model, the requirements to become a registered private hatchery operator or multiplier station are as follows (Tayamen 2004):

a. must be recommended by the Regional Evaluation Team or the Evaluation Team of NFFTC;
b. must meet the technical requirements as specified by the National Breeding Center;
c. must be willing to sign a Memorandum of Agreement containing provisions and conditions, standard cultural and management practices, and dissemination procedures;
d. must be bonafide hatchery operator/owner; and
e. must attend seminars and hands-on training courses conducted by BFAR-NFFTC.

For the multiplication of GMT, accreditation of private sector hatcheries began in 1996. Interested hatchery operators apply for accreditation. Applications are thoroughly screened and reviewed based on a set of criteria. The criteria used in the accreditation of interested hatcheries are based primarily on the ability to maintain quality control, to produce and effectively

Box 1. Procedure for accreditation of GMT multipliers.

1. Applicant will fill up an accreditation form and completely answer a questionnaire.
2. A staff from Phil- Fishgen will visit the farm/ hatchery.
3. After the visit, the Phil- Fishgen Commitee will evaluate the application.
4. If, after the evaluation, the application is approved, the farm/hatchery owner will need to sign a notarized Memorandum of Agreement.
5. He/she will make advance payment for broodstock.
6. The broodstock will be released after above requirements are satisfied. The size of the broodstock is #14-12 or about 3 to 5 g. YY-males are tagged with coded wire tags.
7. The rearing of broodstock will be done in the accredited hatheries' ponds for 2-3 months.
8. After rearing, personnel from Phil- Fishgen will visit the farm/hatchery and sort the broodstock, after which GMT production shall commence.
9. The GMT sample from the first production is subject to sex ratio analysis by Phil-Fishgen.
10. The provisional license will be issued and the GMT production will be periodically sampled for sex ratio determination.
11. After 6 months of satisfactory operation, a full license is issued (with validity for 2 years).

distribute fingerlings, and to have financial stability. The accreditation also includes assessment of: (1) facilities; (2) personnel and management; (3) experience; (4) location; (5) size; (6) financial capability; (7) timing of application; (8) political expediency; (9) exclusivity; (10) security; and (10) ability to promote the technology. Box 1 also features the procedures for accreditation.

Initially, hatcheries were required to pay a royalty to Phil-Fishgen based on the number of GMT produced and sold. However, this scheme failed due to nonpayment of royalties by the majority of hatcheries. The scheme was replaced in 1998/9 by one in which hatchery operators paid for broodstock at the time they were obtained. This switching of schemes created a hiatus in broodstock supply which otherwise has risen (in terms of number of broodstock sets dispersed) year on year. The dispersal of broodstock looked set to fall in 2003 due to increased competition among hatcheries where hatchery operators might shift to other genetically improved breeds of tilapia.

This mode of identifying and accrediting hatcheries is a passive process in which little active marketing or canvassing takes place. As a result, a large proportion of accredited hatcheries are new entrants to the seed production sector (these tend to be more mobile, and more likely to seek new information and be entrepreneurial in adopting new technology), which may explain the rather high dropout rate where new business ventures fail to take off (Clarke et al. 1998). This is the major reason why the majority of accredited hatcheries were removed from the list.

A certification system was devised in which licensed accredited hatcheries were issued with certificates authenticating their product as GMT. Copies of the issued certificates were to be retained by the hatchery and provided to Phil-Fishgen to support monitoring and evaluation activities. This certification system was never fully implemented by accredited hatcheries probably due to a failure to effectively promote the system to potential GMT buyers.

Issues and Concerns

The production and distribution of improved strains of tilapia are very vital to the sustainability of the industry. The distribution mechanisms which are already in place, while they are presently effective, are still far from becoming fully efficient and responsive to the requirements of the industry, and in meeting the ultimate objective of self-sufficiency. Among the important issues and concerns which have been identified are as follows.

Inequitable distribution of improved fish

There is a perception that bigger farms and richer operators are reaping majority of the benefits from tilapia genetics-based technologies. Moreover, accredited private hatcheries are concentrated in the tilapia-producing areas of Central and Southern Luzon. As a result, tilapia farmers in areas not traditionally served by government extension service are deprived of the opportunity to increase their production through the use of better breeds and unavailability of technical assistance. Innovative delivery systems should be implemented.

Quality assurance

Maintenance of quality and insuring the integrity of improved tilapia pose a big challenge to breeding centers in order to sustain the gains achieved in breeding and genetic improvement work. In the absence of a seed certification mechanism, farmers will continue to be offered with products claimed to be the "original".

Product competition

Accredited private hatcheries find it difficult to compete with breeding centers and government hatcheries because of the built-in advantages of the government sector in terms of resources and infrastructure. It is possible to eliminate the undue advantages of the public sector by identifying specific roles and functions of government agencies and private institutions.

Education and awareness

There is a need for more awareness and appreciation of the advantages and impact of using genetically improved tilapia especially with regard to proper handling and transfer of germplasm. Unfortunately, there is a lack of trained human resource to transfer the technology, conduct information campaign and train farmers.

Conclusions

The rapid development of the tilapia industry in Philippines has been largely attributed to the development of genetics-based technologies. The production and distribution of improved tilapia have resulted in the dramatic increase in farm productivity providing farmers with opportunities to improve their income. Another positive result is the recognition by farmers of the importance and advantage of using improved breeds. With a number of improved strains of tilapia now available, farmers have become more discriminating which is a manifestation of progress.

Another promising outcome of this process is the productive partnership between public and private sectors. It is very apparent that for the industry to further develop, the appropriate enabling environment in terms of policy, government programs and private sector participation should be in place to insure the sustainability of the industry.

References

Bolivar, R.B., Z.P. Bartolome and G.F. Newkirk. 1994. Response to within-family selection for growth in Nile tilapia *(Oreochromis niloticus)*, p. 548–551. *In* L.M. Chiu, A.E. Munro, T.J. Lam, T.W. Chen, L.K.K. Chong, J.K. Ding, K.K. Hooi, H.W. Khoo, V.P.E. Chong, K.F. Shin and C.H. Tan (eds.) Proceedings of the Third Asian Fisheries Forum, 26-30 October 1992, Singapore. Asian Fisheries Society, Manila, Philippines.

Capili-Mair, J.B. 1997. Dissemination strategies for the YY male technology and its products, p. 58–68. *In* G.C. Mair and T.A. Abella (eds.) Technoguide for the production of genetically male tilapia (GMT). Freshwater Aquaculture Center, Central Luzon State University, Nueva Ecija, Philippines.

Clarke, G., G. Mair, E. Morales, A. Black and R.C. Sevilleja. 1998. Small-scale farmers and genetics-based technology in Philippine aquaculture. Final Tech. Rep. Socio-economic Analysis of the Dissemination and Impact of Genetically Male Tilapia (GMT) Project funded by the Fish Genetics Research Programme of the Department for International Development, London, UK.

FIDC (Fishery Industry Development Council). 1999. Philippine fisheries industry plan for 1999–2004. Bureau of Fisheries and Aquatic Resources, Department of Agriculture, Quezon City, Philippines.

Mair, G.C., D.O.F. Skibinski, T.A. Abella and J.A. Beardmore. 1997. Genetic manipulation of sex ratio for large-scale production of all-male tilapia, *Oreochromis niloticus*. Can. J. Fish. Aquat. Sci. 54: 396-404.

Mair, G.C., G.C. Clarke, E.J. Morales and R.C. Sevilleja. 2002. Genetic technologies focused on poverty? A case study of genetically improved tilapia (GMT) in the Philippines, p. 197–226. *In* P. Edwards, D.C. Little and H. Demaine (eds.) Rural aquaculture. CABI International, Oxford, UK.

Tayamen, M.M. 2004. Nationwide dissemination of GET-EXCEL tilapia in the Philippines, p. 74-88. *In* R.B. Bolivar, G. Mair and K. Fitzsimmons (eds.) New dimensions in farmed tilapia. Proceedings of the Sixth International Symposium on Tilapia in Aquaculture, 12-16 September 2004, Manila, Philippines.

Disseminating Genetically Improved Tilapia Fingerlings through the GIFT Licensing Program

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Abstract

A nonstock, nonprofit private corporation called the GIFT Foundation International Inc. (GFII) was established in 1998 to continue the selective breeding of the Genetic Improvement of Farmed Tilapia (GIFT) while producing and widely distributing the improved tilapia strain to Philippine farmers. To meet the objectives for which it was established, the foundation created a GIFT licensing program which was designed not only to provide for the multiplication and wide distribution of GIFT fingerlings to the industry but also to provide the foundation with revenues to cover its operating and breeding costs. This paper discusses the roles of key players in the GIFT licensing program and the lessons learned in involving the private hatcheries in the dissemination of genetically improved tilapia strain.

Introduction

When the GIFT Project ended in 1997, it had successfully achieved its primary objective – to prove that selective breeding, as successfully applied by the Institute for Aquaculture Research in Norway (AKVAFORSK) to salmon, could be applied to a tropical fish species like Nile tilapia. In the process, the project was also able to develop an improved Nile tilapia, called GIFT strain, which had responded very well to selection for growth.

To ensure that the GIFT strain would have wide impact in developing countries, the project spawned a number of breeding programs through the distribution of GIFT fish of various generations to several countries to serve as founder stock for their own tilapia breeding programs. GIFT family materials were distributed to government agencies in Thailand, Indonesia, Vietnam, Philippines, Fiji, China and Bangladesh. At the expiration of the GIFT Project, the project's implementing agency, International Center for Living Aquatic Resources Management (ICLARM) (now WorldFish Center) was provided with family materials from the last selective breeding experiment conducted by the project. GIFT fish continue to be available to public sector breeding programs through the WorldFish Center.

The rest of the project fish collections and the project's main breeding nucleus were transferred, at the end of the GIFT Project, to GFII. The GFII is a private nonstock nonprofit corporation established by the GIFT Project's institutional partners to continue selective breeding of the GIFT strain on a self-sustaining basis. The challenges faced by the foundation when it was organized in 1997 were to continue the selective breeding effort on the GIFT strain while intensively producing and widely distributing GIFT tilapia fingerlings to farmers in Philippines.

When GFII was established in 1997, all parties recognized that it did not have the resources and the competencies to intensively produce and widely distribute GIFT fingerlings to farmers in Philippines on top of carrying the breeding program forward.

To meet the objectives for which it was established, the foundation decided to pursue a strategy involving partnerships and alliances with private sector entities. The foundation, since it started, has been a continuing experiment in mobilizing resources from and involving the private sector in genetic improvement/breeding programs, seed production and distribution, technology transfer to farmers and other industry development activities.

The GIFT Licensing Program

The GFII established a hatchery-licensing program under which privately owned hatcheries were invited to apply to become licensed GIFT hatcheries. Under the program, all hatcheries meeting a specific set of criteria (practically all having to do with hatchery production facilities) could become GIFT hatcheries upon entering a Hatchery Agreement with GFII.

The GIFT Licensing Program was designed not only to provide for the multiplication and wide distribution to the industry of GIFT fingerlings but also to provide the foundation with monthly revenues to cover its operating and breeding costs.

The terms of the Hatchery Agreement included, among others, the following:

1. payment of an upfront licensing fee;
2. payment of a monthly R&D contribution to the foundation (contribution based on a formula taking into consideration number of breeders, standard production of fingerlings per breeder and a percentage of the selling price of the fingerlings);
3. agreement by the hatchery operator to undergo, together with the hatchery's technical staff, a training program to be delivered by the foundation;
4. policies on breeder deliveries and replacements (including fees, if any, to be charged for replacements);
5. agreement by the hatchery operator to follow product standards and hatchery operating procedures, if any, to be specified by the foundation;
6. marketing responsibilities;
7. agreement by the hatchery operator to abide by pricing guidelines to be established by the foundation;
8. agreement by the foundation for the hatchery operator to use the "GIFT Super Tilapia" registered trademark;
9. reporting procedures, formats and schedules;
10. defaults and termination procedures; and
11. renewal options.

Although many hatcheries expressed keen interest in becoming accredited GIFT hatcheries, only seven hatcheries signed up for the licensing program during the period when the foundation was actively recruiting hatcheries into its licensing program. Hatcheries which did not sign up for the program indicated that they were not comfortable with the legal documentation, the upfront license fee, monthly R&D contributions and what appeared to be very strict maintenance requirements.

The active recruitment of hatcheries for the licensing program was discontinued two years after it started as part of the foundation's agreement with GenoMar. Out of the seven hatcheries that signed up for the program, six stayed on until the program ended in late 2002.

Roles

While the GIFT Licensing Program was in operation, the roles of the foundation and the licensed hatcheries were quite clear. Some of these roles were spelled out in the Hatchery Agreement. Other roles evolved from the interactions between and among the hatcheries and the foundation during the five years of the program.

The foundation's roles were the following:

- to maintain the GIFT genetic improvement program;
- to provide the licensed hatcheries with breeders, breeder mortality replacements and breeder upgrades on-loan;
- to train the hatchery operators and their staff in hatchery production systems;
- to monitor the performance of the hatcheries and to provide them with technical support/ assistance;
- to coordinate the group's efforts to establish product quality standards and improve hatchery production systems;
- in consultation with the hatcheries, to look after the development of the GIFT Super Tilapia ™ brand on a national level; and
- to conduct farmer training seminars.

The roles of the GIFT licensed hatcheries were the following:

- to maintain the foundation's breeders and to give them appropriate care;
- to produce GIFT fingerlings;
- to market GIFT fingerlings directly to tilapia farmers;
- to cooperate with the group's efforts to improve hatchery production systems; and
- to participate in the development and maintenance of the GIFT Super Tilapia brand.

The foundation religiously met with the hatcheries on a monthly basis. During these monthly meetings, information was shared and solutions to common problems were discussed. These meetings also served to strengthen the working relationships of the hatcheries while reinforcing the coordinating and leadership role of the foundation.

The GenoMar Relationship

In 1999, GFII entered into an agreement with GenoMar ASA, a private Norwegian company primarily involved in aquaculture biotechnology. The GIFT Foundation agreed to transfer a portion of its tilapia breeding nucleus to GenoMar and, under specific conditions, to channel its future commercial activities through GenoMar. In return, the foundation received an equity position in GenoMar as well as certain rights to produce and distribute improved tilapia strains developed by GenoMar.

The foundation sees in this commercial alliance with GenoMar a great potential for accelerated genetic development targeted at the commercial intensification of tilapia production. Commercial intensification is expected to have a significant impact on the aquaculture industry's ability, in the light of increasing populations and declining fish catches, to produce the volumes of fish required for food security in developing countries.

Although the foundation considers its licensing program with private hatcheries a modest success (reaching total annual distribution of over 250 million fingerlings), it sees the alliance with GenoMar as necessary to boost, with the aid of genomics and bioinformatics tools, the continuous improvement of the GIFT strain. Improvements in breed performance as well as improvements in the efficiency and productivity of hatchery and growout systems are sorely needed for the long-term sustainability of tilapia aquaculture. The GFII also recognizes that active competition in the aquaculture industry will provide farmers and consumers with higher quality and better value products and services.

As part of its agreement with GenoMar, the foundation allowed the pretermination of licensing agreements with the GIFT hatcheries that enter into an agreement with GenoMar for the multiplication and distribution of GenoMar tilapia fingerlings. As mentioned earlier, these agreements were signed by the hatcheries in 2001 and the commercial production and distribution of GenoMar Supreme Tilapia ™ fingerlings started in late 2002. Six of the seven GenoMar partner hatcheries were the original GIFT licensed hatcheries.

The foundation recognizes that the commercial GIFT line that it had spun-off to GenoMar will now move forward on its own in response to perceptions of what the market needs, what the market will pay for and what will provide the best return to private investors. Nevertheless, the GFII will continue, on its own or in collaboration with others, to conduct selective breeding research and activities that may not be commercially attractive but which are important for and relevant to sustainable development concerns of developing countries. The foundation hopes to finance these activities from the resources mobilized from the its commercial pursuits.

Lessons Learned

The GIFT Licensing Program allowed the GIFT Foundation, at a time when it did not have the expertise in nor the resources to conduct commercial-scale seedstock production, to utilize privately owned hatcheries to produce and distribute genetically improved tilapia seedstock very quickly and effectively. While the model may appear simple enough for other breeding programs to adopt for multiplication and distribution, the following points have to be considered in future attempts to involve private hatcheries in the dissemination of genetically improved seedstock.

1. Legal documentation, licensing and royalty fees, and other requirements served to limit the hatchery operators attracted to the GIFT Program to those who seemed to have better education, greater familiarity with business procedures, greater interest in technology, and access to capital or financing to invest in hatchery systems. Limiting the availability of improved breeds to such parties has advantages as well as disadvantages. Advantages include production efficiencies, product quality and the ability to build a brand image. Disadvantages, on the other hand, include limitations in providing all hatcheries, and therefore growers, with access to improved breeds, slower buildup of production and distribution capability, and possibly higher seedstock prices to recover increased costs of broodstock.

2. The foundation was initially disappointed over the number of hatcheries that it was able to recruit to its licensing program. However, it eventually realized that: (a) only a few hatcheries are required to service the industry and (b) the foundation probably did not have the capability to manage relationships with a large number of licensed hatcheries. In essence, the recruitment of a large number of hatcheries would most likely have become a disaster for the foundation.

3. Maintaining close working relationships with and fostering good relationships among the licensed hatcheries has proven to be critically important. Although doing so requires significantly more effort, the benefits include better market monitoring and feedback, more insights on the part of the foundation on the true needs of hatcheries and their customers, and an increased capacity to address production challenges.

4. A breeding program and the dissemination infrastructure it eventually builds should be closely in tune with the requirements, needs and capacities of the industry it is serving.

Effects of Evolving Partnerships on Access to and Uptake of Tilapia Genetic Improvement Technologies and Their Products: Results of Survey and Policy Implications

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Abstract

The study determined and evaluated the effects and impact of public-private partnerships on access to and uptake of the products of tilapia genetics research to end-users. Specifically, the dissemination procedures and mechanisms for the distribution of genetically improved tilapia were described, and the product recipients or beneficiaries were identified.

Of the four genetically improved tilapias being commercially produced and distributed, three are being disseminated through public-private partnerships while one is distributed exclusively to private hatcheries. There are two modes of access: open access and through licensing where recipients of improved tilapia broodstock undergo accreditation using specific selection criteria.

The profile of users based on land ownership shows that genetics-based technologies for tilapia are scale-neutral. However, the capital requirement for tilapia farming is relatively high. As a result, users of genetically improved tilapia are farmers who have access to capital from their own personal sources indicating that well-off farmers are reaping the benefits of tilapia genetics technology.

Results of the study illustrated the weaknesses of the traditional extension delivery system. Access to information and technical assistance by users of improved tilapia is mainly through fellow farmers and suppliers of fish. This manifests the potentially significant role that the private sector can play in the transfer of genetic technology and its products. Results of the study likewise indicated that technology diffusion and adoption is not very evident among users of improved tilapia, especially in areas which are not effectively served by government extension services. However, majority of the farmers have positive attitude towards tilapia farming.

Introduction

The development and dissemination of genetics-based technology for the production of tilapia have resulted in significant increases in farm productivity. This has been significantly manifested since 1998 with the availability of several genetically improved tilapia developed out of R&D partnerships between public and private sectors. Such alliances have accelerated the overall growth of the industry leading to the growing importance of tilapia production to aquaculture in particular and to economic development in general.

However, no research has been done to determine and evaluate the impact of such public-private partnerships in the attainment of development objectives, particularly the effects of existing distribution or dissemination pathways on the uptake of genetics-based technology. In the absence of such research, it is very difficult to identify the beneficiaries of the introduced technologies and more importantly, the groups of producers who may be adversely affected, marginalized and left out from the benefits of the new products.

The general objective of this study was to determine and evaluate the effects and impact of public-private partnerships on access to and uptake of the products of tilapia genetics research. The specific objectives were as follows: (1) describe dissemination procedures for the delivery of research products; (2) identify product recipients or beneficiaries; (3) analyze access to and uptake of the technologies; and (4) make recommendations for policy formulation

Methodologies

A stakeholders workshop and a farm survey were implemented to achieve the objectives of the research as enumerated above.

Stakeholders workshop

A three-day workshop was organized in June 2003 in Angeles City, Philippines, to bring together participants from various stakeholder groups in the tilapia industry; namely, tilapia farmers, research and development (R&D) workers, policymakers, government officials and industry representatives. The objectives were to solicit first-hand information and impressions regarding the effects of public-private partnerships on the attainment of development objectives of tilapia genetics research and to identify, discuss and analyze issues, problems and other concerns regarding the delivery and uptake of genetics-based technology.

Table 1. Distribution of samples/users of genetically improved tilapia.

Strain	Growout					Hatchery				
	Region					Region				
	I	II	III	IV	Total	I	II	III	IV	Total
GIFT/GST	4	3	42	1	50	–	–	5	1	6
GET/EXCEL	4	4	42	–	50	7	9	31	14	61
YY/GMT	4	6	37	3	50	3	–	8	5	16
FaST	–	6	44	–	50	1	3	11	2	17
Total	12	19	165	4	200	11	12	55	22	100
%	6	9.5	82.5	2	100	11	12	55	22	100

Field survey

This activity was conducted to collect the needed data and information for the research. The study area covered four regions in Luzon, the biggest island of Philippines. These are Regions I, II, III and IV, consisting of 15 provinces (Table 1). In year 2000, these four regions had a combined tilapia production of 78,491 t or approximately 95% of the national total production (BFAR 2001).

Primary and secondary data were gathered for this study. Primary data were collected through personal interview using three types of questionnaires: for the institutional developers of the improved tilapia; for growout farmers; and for hatchery operators. Data and information for the 2002 production year were considered for the survey. Sample-respondents were hatchery and pond growout farmers using the four genetically improved tilapia, namely, GIFT/GST (Genetically Improved Farmed Tilapia/GIFT Super Tilapia/Genomar Supreme Tilapia); GET/EXCEL (Genetically Enhanced Tilapia); YY/GMT (Genetically Male Tilapia); and FaST (FAC Selected Tilapia). The number of samples for growout farmers was set at 200, equally distributed at 50 samples per strain of improved tilapia. For hatchery operators, the total number of samples was 100 farmers broken down as follows: 6 for GIFT/GST; 61 for GET/EXCEL; 16 for YY; and 17 for FaST. Samples were drawn using stratified random sampling procedure. The distribution of the sample-farmers by region and by strain is shown in Table 1.

Highlights of Results

Significant advances have been achieved in the field of tilapia genetics R&D in Philippines over the last 15 years. Genetically improved tilapia developed from collaborative research partnerships is now being distributed and widely adopted by farmers through different procedures and mechanisms. Consequently, public and private sector institutions have become involved in this process. Partnerships and strategic alliances have been established, aimed at sustaining the gains achieved in the R&D stages. Despite significant strides and progress achieved on product dissemination, there is an urgent need to address major issues and concerns related to effectivity, efficiency and accessibility.

This study presents an extensive analysis of these processes in the light of public-private sector participation in the distribution of products of tilapia genetics research to end-users.

Products of tilapia genetics research

This study focused on the fish (improved tilapia breeds or strains) as the major products of research being disseminated to end-users. These include fry or fingerlings for growout and broodstock for hatchery operation. The improved tilapia strains considered in this study were GIFT/GST of the GIFT Foundation International, Inc. (GFII); GET/EXCEL of the National Freshwater Fish Technology Center, Bureau of Fisheries and Aquatic Resources (NFFTC-BFAR); YY/GMT of the Phil-Fishgen, Freshwater Aquaculture Center, Central Luzon State University (FAC-CLSU); and FaST, also of the FAC-CLSU.

Product profile

Table 2 shows some selected general information regarding the improved tilapia strains. It can be noted that the improved strains of tilapia have been given their commercial or popular name, which is either based, from the technology used to develop them or from the project, which initiated their development. This is the case with the GIFT/GST, YY tilapia and FaST. It can be noted further that three of the improved tilapias were developed using selection procedures with only YY and GMT being produced using genetic sex manipulation techniques.

FaST was the first improved tilapia to be commercially disseminated. It was initially distributed in 1993 as the International Development Research Centre (IDRC)-selected tilapia, a reference to the funding agency, which supported the research project, which resulted in its development. Among the improved tilapia, only the GIFT/GST breeding nucleus is privately owned.

Modes of access and distribution pathways

There are two modes of access to improved tilapia from the breeding nucleus to users. The first is through open access where no acquisition requirements are imposed from recipients of the fish. Among the different improved strains, only FaST could be obtained through open access as shown in Table 3. The other mode of access is through licensing, accreditation or certification (these terms are used in this report synonymously). Under this mode, the hatchery partners or multipliers are required to abide by some terms of agreement.

Table 3. Modes of access to genetically improved tilapia by strain.

Strain	Mode of access	
	Broodstock	Fish for growout
GIFT/GST	Licensing	Open
GET/EXCEL	Certification	Open
YY/GMT	Accreditation	Open
FaST	Open	Open

Presented in Box 1 is the simplified schematic diagram of the distribution pathways or dissemination channels for each of the improved tilapia strains. There are distinguishing differences among the distribution pathways, which the different improved fish go through. Under the distribution scheme for GET/EXCEL, there are two types of multipliers. The first level is the central hatcheries located in each of the Regional Outreach Stations of BFAR, Department of Agriculture (DA). The second level multipliers referred to as satellite stations consist of DA provincial hatcheries, local government unit hatcheries, state universities and colleges, and private hatcheries. These multipliers perform different functions. The former mass-produce the GET/EXCEL broodstock, duplicating the function of the National Broodstock Center (breeding nucleus), while the latter's function is the mass production of fry/fingerlings for growout operation. In the case of the other strains, tilapia broodstock for hatcheries are obtained only from the breeding nucleus or centers.

The breeding nucleus for GIFT/GST, GET-EXCEL and YY/GMT produce and distribute both broodstock for hatchery operation and fry/fingerlings for growout farming. Only FaST is distributed from the breeding nucleus as broodstock. In other words, the product developers or breeding nucleus also deal directly with the ultimate users of the improved fish by distributing or marketing fish for growout operation.

Table 2. General information on tilapia genetics-based fish products being distributed.

Improved tilapia (commercial/ popular name)	Breeding nucleus ownership	Breeding technology used	Year distributed	Distribution partnership
GIFT/GST	Private	Selection and DNA Technology	1998	Private
GET/Excel	Public	Combined family and within family selection-rotational mating	2000	Public-private
YY-male and XX-broodstock and GMT	Public	YY-male technology (genetic sex manipulation)	1995	Public-private
FaST[1]	Public	Within family selection	1993	Public-private

[1]This fish was initially distributed as IDRC-selected tilapia. It was renamed as FaST in 1998 and distributed only as broodstock.

Profile of users of genetically improved tilapia

One of the main objectives of this research is the identification of the users or recipients of the products of tilapia genetics research. Thus, the study examined whether a particular group of farmers has favorably benefited compared to others. By knowing who the product beneficiaries are, it is possible to evaluate if the development objectives of genetics-based technologies are adequately met. Hence, many questions were addressed. Some focused on the economic and technical environment in which farmers operated. Others were related to the manner in which farmers made decisions regarding the use of improved tilapia strains.

Box 1.Distribution pathways for genetically improved tilapia.

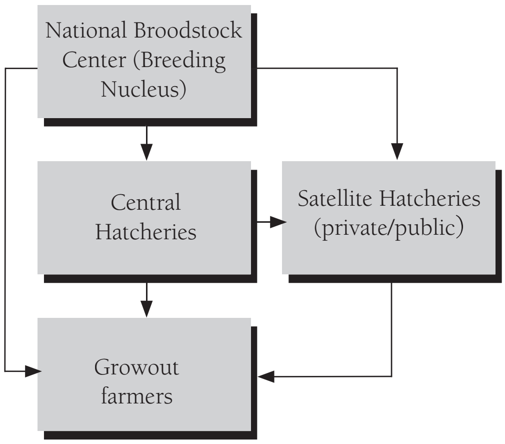

Figure 1. GET/EXCEL pathway.

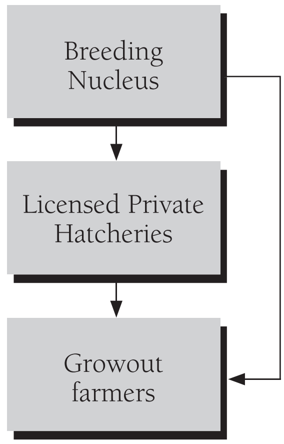

Figure 2. GIFT pathway.

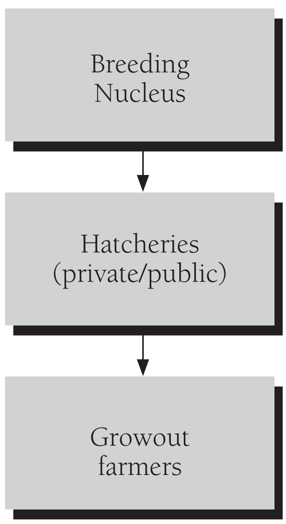

Figure 3. FaST pathway.

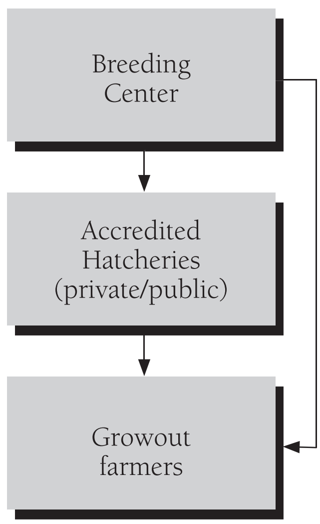

Figure 4. YY/GMT pathway.

Selected sociodemographic characteristics

The average age of tilapia farmers using genetically improved tilapia strains is 44 years (Table 4). Among the various groups of farmers, FaST hatchery farmers are the youngest at 38 years of age, while the oldest are GMT growout farmers at 48 years age. Although tilapia culture is a male-dominated activity, there is significant women participation as shown in the table. The average size of a tilapia farming household ranges from 4 to 11 members.

The respondents have been engaged in tilapia farming for up to 9 years with hatchery farmers having been in the business longer than the growout farmers. It can be noted that hatchery operators became initially engaged in tilapia farming at about the time that the technology for the production of improved tilapia was being developed and the dissemination of improved strains was at its initial stages. This could have served as a motivating factor for farmers to adopt the technology. Furthermore, this could probably be considered as an indication of the possible participation of the private sector in the technology development process.

The educational attainment of the farmers is relatively high with majority of the operators having gone through some college education. In general, hatchery farmers have higher educational attainment than the growout farmers. Among the different groups of users, farmers using GIFT/GST have the highest level of education. These findings tend to indicate that farmers with relatively higher levels of education are more in a position to receive the benefits of genetics-based technology. This could be explained by the technical knowledge that is required in tilapia farming. This is more notably manifested in hatchery operation where a higher level of expertise is required.

Tilapia farming as source of income

Table 5 shows that tilapia farming is only a secondary source of income among majority of the farmers but its contribution to their total income is substantial, ranging from 34 to 74%. Among the different groups of growout farmers, only FaST users consider tilapia farming as their primary source of income while among hatchery operators, GIFT/GST and GET/EXCEL users belong to the same classification. GMT/YY growout and hatchery farmers have higher composition of farmers who consider tilapia farming as a secondary source of income (16:84% and 25:75%, respectively) compared to the other groups, likewise having the least contribution to their total income at 35 and 34% for growout and hatchery, respectively.

Table 5. Tilapia farming as source of income by users of different strains of genetically improved tilapia.

Users	Tilapia farming as source of income of farmers (%)		% of income from tilapia farming
	Primary	Secondary	
Growout			
GIFT/GST	24	76	39
GET/EXCEL	20	80	38
GMT	16	84	35
FaST	60	40	74
Hatchery			
GIFT/GST	83	17	64
GET/EXCEL	55	45	56
YY	25	75	34
FaST	47	53	61

Table 4. Selected sociodemographic characteristics of users of genetically improved tilapia.

Users	Age (years)	Gender (% of farmers)		Household size (no.)	Experience (years)	Education* (% of farmers)
		Male	Female			
Growout						
GIFT/GST	46	88	12	4	6	68
GET/EXCEL	45	82	18	4	5	48
GMT	48	94	6	5	6	56
FaST	46	90	10	5	6	42
Hatchery						
GIFT/GST	43	67	33	11	9	100
GET/EXCEL	44	94	6	6	9	80
YY	46	100	0	6	6	75
FaST	38	71	29	7	8	88

* Farmers with some college education, with college and postgraduate degrees.

Issues and Areas of Concern with Policy Implications

This study was conducted at a critical time when the tilapia industry is experiencing unprecedented growth, and at the same time, confronted with concerns about the technical, economic and environmental sustainability of production systems. The increasing popularity of tilapia farming is spurred by several factors, foremost of which is the availability of improved strains of tilapia which are now being commercialized and widely distributed through public and private partnerships. The expanding opportunities for tilapia production in Philippines, a country known for its aquaculture tradition and expertise, pose many challenges to the industry. These challenges come at a time when the tilapia industry sector is somewhat in a transition and undergoing some dynamic changes. Corporate participation in tilapia farming is expanding. Breeding and commercial tilapia seed production has been, historically, the domain of publicly funded institutions. Recently, however, the private sector has played an increasingly important role in the production of genetically improved strains of tilapia.

The following sections outline several important areas of concern and issues, which have been identified as having significant policy implications. These are also considered as vital in providing information for a better appreciation and understanding of the various aspects of public-private partnerships in genetics research. In the succeeding discussions, the issues and areas of concern as identified during the stakeholders' workshop are presented. The relevant results of the farm survey are then presented in parallel to these issues for confirmation and validation.

Distribution of benefits

Probably the most important area of concern relative to the dissemination of genetically improved tilapia, just like in most introductions of technologies, is the distribution of benefits. There is concern that the current dissemination mechanisms are not ensuring equitable delivery of benefits of genetics-based technologies. Marketing of improved fish seeds from most private sector hatcheries (particularly the hatcheries accredited to produce them) is mainly concentrated in Luzon. Due to limitations in product distribution arising from the geographical location of farmers, big and commercial aquaculture producers have easier product access due to their better capability to absorb the additional transportation cost compared to small farmers.

One of the objectives of the research is the identification of the recipients or beneficiaries of the products of tilapia genetics research. Ownership of and access to resources is the most common criterion used to describe adopters of technologies. In this study, the indicative variables used for this purpose are land and capital.

Land ownership and utilization

In Philippines, much else follows the amount of land one owns. Access to other factors of production is highly correlated with ownership and access to landholding. It influences to a great extent the process and development in aquaculture because it undermines decisions on production and their corresponding consequences on growth and distribution.

Land and fishpond ownership of farmers using genetically improved tilapias is shown in Table 6. The average total land area is 3.57 and 4.71 ha for growout and hatchery operators, respectively. These areas are bigger than the average landholding of a typical Filipino farmer. Among users of different strains, FaST growout farmers own the biggest total land area at 6.84 ha. Among hatchery owners, GIFT/GST users are the biggest landowners with a total of 10.53 ha land area. These two groups also have the biggest average fishpond areas of 4.62 and 2.18, respectively, among the different groups of GIFT users. The land utilized for fishponds constitutes about 56% and 34% for growout and hatchery operations, respectively.

Data on the distribution of land show the inequality of land ownership and a high degree of fragmentation, which characterizes Philippine agriculture. As shown in Table 7, majority of the farmers (more than 60%) own land less than 3 ha in size, with about 25% of the users owning less than 1 ha. The exception, however, are GIFT/GST hatchery farmers whose land ownership exceeds 4 ha in size. About 50% of the farmers own more than 7 ha of which under the Comprehensive Land Reform Program of the country, individual farmers are allowed to own a maximum of 7 ha of riceland. No such maximum-size ownership limitation is imposed for land utilized for aquaculture.

Table 6. Total land and fishpond ownership of users of genetically improved tilapia.

Users	Total land area (ha)	Fishpond area (ha)	% fishpond to total area
Growout			
GIFT/GST	2.38	1.07	45
GET/EXCEL	2.62	1.47	56
GMT	2.61	0.99	38
FaST	6.84	4.62	68
All strains	3.57	2.01	56
Hatchery			
GIFT/GST	10.53	2.18	21
GET/EXCEL	4.25	1.39	33
YY	4.89	1.98	40
FaST	4.12	1.74	42
All strains	4.71	1.59	34

Table 7. Percent distribution of farmers by size of land.

	Growout (% of respondents)					Hatchery (% of respondents)				
Size range (ha)	GIFT/ GST	GET/ EXCEL	GMT	FaST	All strains	GIFT/ GST	GET/ EXCEL	YY	FaST	All strains
≤1.0	29	22	30	13	24	–	27	6	35	26
1.1–2.0	38	36	26	17	29	–	27	31	–	22
2.1–3.0	8	10	19	13	13	–	10	31	17	15
3.1–4.0	8	12	9	4	8	–	5	–	–	3
4.1–5.0	4	6	2	9	5	33	6	6	24	10
5.1–6.0	4	8	4	8	6	–	2	–	–	1
6.1–7.0	–	4	4	7	4	17	8	6	–	6
>7.0	9	2	6	28	11	50	15	19	24	17

Ownership and access to capital

Data on the amount of capital for genetically improved tilapia farming are presented in Table 8. The average investment ranges from the lowest amount of PhP136,603[a]/ha for FaST users and PhP455,141/ha for GMT growout farmers. Hatchery operators invest higher amounts with the amount ranging from PhP419,424/ha for GET/EXCEL users to PhP2,995,413/ha for GIFT/GST farmers. Of the total amount invested, approximately 57-92% was sourced out from the personal funds of the farmers.

Table 8. Amount and source of capital investment.

	Growout				Hatchery			
	GIFT/ GST	GET/ EXCEL	GMT	FaST	GIFT/ GST	GET/ EXCEL	YY	FaST
Amount of investment (PhP)								
Per farm	178,015	372,410	450,590	631,106	6,530,000	583,000	1,296,625	1,153,235
Per hectare	166,369	253,340	455,141	136,603	2,995,413	419,424	654,861	662,779
Sources (%)								
Own money	68	92	88	60	75	81	74	66
Share of partner	14	3	6	3	–	8	26	15
Loan from bank	11	–	3	14	–	6	–	7
Loan from family members and/or friends	7	5	3	23	25	5	–	12

[a] In January 2004: US$1 = PhP55.

In general, majority of the owners of genetically improved tilapia are small land owners indicating that genetics-based technologies for tilapia tend to be scale-neutral. However, a high amount of capital is required in order to operate tilapia farming business which may be beyond the reach of poor farmers. Hence, it can be deduced that farmers using genetically improved tilapia, although generally not owning large tracts of land, are well-off because they have ready access to capital from their own sources thus marginalizing small farms. This result illustrates the lack of a dissemination mechanism, which specifically targets “small and poor tilapia farmers”. Based on the results of the study, it further appears that the beneficiaries of the GIFT/GST distributed through private partnerships are mainly large farms operated by rich farmers.

Provision of technical assistance

The need for improved extension services to hatcheries and growout farmers was recognized. In addition to the traditional extension services provided by the public sector, specialized extension support services (e.g., hatchery technology, soil and water quality analyses, feeding management, management of improved fish breeds) are needed.

Acquisition of tilapia farming knowledge

Farmers acquired their technical knowledge on tilapia culture from several sources, i.e., training programs/seminars, self-study, and friends and fellow farmers (who are mentioned as the most common sources) (Table 9). Extension workers and mass media (radio and television) have not been fully utilized by farmers as sources of tilapia farming knowledge. The data further show that majority of the farmers have undergone formal training.

A closer examination of the data shows that the most common sources of information varied among different groups of farmers. Among hatchery and pond growout farmers, training programs and seminars were the main sources. This could be due to the technical services provided by the breeding centers. For example, NFFTC of BFAR conducts a free weekly seminar series, which is open to the public. Participants can just walk in and attend the said seminar. On the other hand, a training is required for hatchery farmers in order to become accredited, certified or licensed users of technical knowledge of the improved tilapia strain of GIFT, GET-EXCEL and YY-broodstock.

These results illustrate both the general weaknesses and strengths of existing extension delivery systems as well as the effectiveness of extension agents. Data shown in Table 10 validate this finding where only about 30-68% of the farmers were visited by external technicians and consultants. A higher number of farms (65-92%) received technical advice from suppliers of fish (government or private). The foregoing data illustrate the important role that farmers and private sector producers can play in the delivery of technical information. Because of their direct participation in the distribution of improved tilapia, they could be harnessed as strategic partners in the dissemination process.

In response to queries regarding the areas where the farmers need technical assistance, the common areas mentioned across the various groups of users are the highly specialized fields of fish breeding, nutrition, fish health and water quality (Table 11).

Table 9. Sources of technical knowledge in tilapia farming.

	Growout				Hatchery			
	GIFT/ GST	GET/ EXCEL	GMT	FaST	GIFT/ GST	GET/ EXCEL	YY	FaST
Source of knowledge in tilapia farming (% of responses)								
Formal education	2	–	2	2	25	3	5	9
Training/seminar	21	20	23	28	31	35	28	24
Self–study	17	29	18	20	13	25	15	11
Through friends	19	17	16	17	13	8	13	11
Fellow farmers	12	9	12	17	–	7	15	4
Extension workers	5	8	10	5	–	10	10	9
Books/pamphlets/brochures	10	13	11	5	19	10	10	30
Radio/TV	14	4	9	6	–	3	3	2
Farmers with formal training	(% of farmers)							
With training	58	56	56	60	100	77	81	76
Without training	42	44	44	40	0	23	19	24

Table 10. Access to technical advice.

	Growout (% of farms)					Hatchery (% of farms)				
	GIFT/ GST	GET/ EXCEL	GMT	FaST	All strains	GIFT/ GST	GET/ EXCEL	YY	FaST	All strains
Farms with resident technicians	8	8	4	12	8	100	18	31	29	27
Farms visited by external technicians or consultants	30	32	32	68	41	67	51	44	35	43
Farms receiving technical advice from fish suppliers	84	78	76	90	82	67	88	87	65	82

Table 11. Areas needing technical advice.

Areas	Growout (% of responses)					Hatchery (% of responses)				
	GIFT/ GST	GET/ EXCEL	GMT	FaST	All strains	GIFT/ GST	GET/ EXCEL	YY	FaST	All strains
Fish breeding	14	16	16	12	15	25	23	23	20	23
Nutrition	27	23	24	23	25	25	22	23	20	22
Fish health	29	22	25	31	27	25	23	21	22	23
Water quality	18	26	22	22	19	15	20	20	22	20
Engineering	2	4	5	1	4	–	3	5	9	4
Marketing	9	7	6	10	8	10	9	5	5	7
Others (financing, economic analysis, information on new improved strain)	1	2	2	1	2	–	–	3	2	1

Product promotion and marketing

Concern was expressed that public sector agencies (breeding centers) may only be promoting their own products and that there may be competition between public and private sector dissemination activities. Multipliers and growout farmers require information on markets, and marketing of tilapia and its products.

Use of genetically improved tilapia

The availability of several strains of genetically improved tilapia has the distinct advantage of providing farmers with different alternative choices. As a result, farmers have become more aware of the benefits of using improved tilapia by being more discriminating in their choices on what particular strain to use.

Table 12a lists down the main reasons why farmers chose a particular strain. The common reasons given by growout farmers relate to biological traits, such as fast growth, high survival and uniform size at harvest. For hatchery operators, a premium is placed on the growth of the fingerlings produced by the broodstock, high demand for fingerlings, better survival of breeders, high fingerling production and reasonable price (Table 12b). Among growout users of the different strains, GET/EXCEL farmers indicated accessibility (20%) and reasonable price (17%) as the primary reasons for choosing the strain, followed by fast growth and availability of supply when needed (15%). These factors are attributed to the government support given to the breeding nucleus and the more widely distributed multipliers of the fish.

It can be noted from this information that availability of supply when needed is not mentioned as prominently as the biological reasons, although indicated as more important by growout farmers than by hatchery operators. In other words, this could be interpreted to mean that, in general, the availability or supply of improved strains of tilapia has increased. However, better access and more availability are still desired in certain geographical areas. This was prominently mentioned as a concern during the stakeholders workshop. Furthermore, accessibility of the source and easy acquisition requirements do not figure prominently among the reasons given as bases for the choice of strain. This could further be interpreted that overall, these reasons no longer pose any major problems or constraints on the access to products of tilapia genetics research, denoting some degree of effectiveness of the existing dissemination mechanisms.

Table 12a. Reasons for choice of genetically improved tilapia strain by growout farmers.

Reasons	Growout (% of responses)				
	GIFT/GST	GET/EXCEL	GMT	FaST	All strains
Fast growth	21	15	19	20	19
High survival	11	11	14	9	11
Late maturity	8	4	12	4	7
Uniform size at harvest	12	3	12	16	10
Good color and body appearance	4	3	7	9	6
Reasonably priced	9	17	10	12	12
Available supply when needed	10	15	9	8	11
Accessible source	9	20	6	10	9
Easy acquisition requirements	5	10	4	5	6
Assurance of technical support	7	8	5	6	7
Others (good market value, post-harvest reasons)	3	1	2	1	2

Table 12b. Reasons for choice of genetically improved tilapia strain by hatchery farmers.

Reasons	Hatchery (% of responses)				
	GIFT/GST	GET/EXCEL	YY	FaST	All strains
High demand of fingerlings	17	16	11	11	14
Better growth of fingerlings	20	16	17	17	17
High fingerling production	13	11	11	10	11
Better survival	10	14	16	13	14
Early maturity	3	2	7	4	3
Longer reproductive ability	3	3	13	9	6
Reasonably priced	10	12	10	10	11
Available supply when needed	8	8	2	8	7
Accessible source	3	6	4	8	6
Easy acquisition requirements	3	4	1	5	3
Assurance of technical support	10	8	8	5	8

Sources of stock

Table 13 shows that majority of the farmers (75.5%) obtained their stock from the breeding centers. On the other hand, private farmers supplied the tilapia stocks of approximately 20% of the farmers of which 11% are located within the province. A similar trend is observed with regard to the sources of stock for pond growout farmers (65.3%). For hatcheries, the number of farmers who obtained fish from the breeding centers is expectedly higher at 85.5% of the total. This is because broodstocks of the improved strains are only produced at their respective breeding centers or nucleus with only GET-EXCEL broodstocks being produced at their first level multiplier stations.

Under the distribution channels established by the breeding centers, users of genetically improved tilapia can now have different sources from where to obtain their stock. This is one of the main advantages of the public-private partnership which has been established to facilitate the distribution of the products of tilapia genetics research. Data show, however, that majority of the farmers still prefer to obtain improved tilapia stocks from the breeding nucleus. Under this scenario, the product developers are being perceived as competitors by the multipliers because they capture a substantial share of the market, especially of fingerlings. Several reasons could be postulated to explain this situation. It would appear that fish from the breeding nucleus are superior in quality or farmers are more certain of the quality of the product if they obtain them directly from the breeding center. Other reasons could be associated with price or the assurance of technical assistance.

Survey results further show that in general, majority of the farmers (89%) obtain their fish stocks from the same source (Table 14). This is most evident among hatchery operators where nine out of ten farmers use stocks from the same source. On the average, more than 86% of the farmers also stated that improved tilapia stocks are available anytime when needed, and at prices that are satisfactory to them. There was also an affirmative response by majority of the farmers across various groups to the question on whether they would be wiling to try new strains of tilapia if available.

The foregoing information could be imputed as the satisfaction level by the users of improved tilapia where a generally positive attitude towards its use is expressly manifested. The survey results also illustrate the traditional pattern of technology adoption where potential users do not immediately adopt even an excellent product. They tend to observe the outcome of the trial that is being conducted by other farmers before adopting the technology. However, it is encouraging to note that a big majority of potential users of products of tilapia genetics technology are willing to adopt them.

Table 13. Sources of improved tilapia stock being used.

Source	% of farmers		
	Growout	Hatchery	All farmers
Breeding centers	65.3	97.0	75.5
Government multipliers:			
within region	0.5	1.0	0.6
outside region	–	1.0	0.3
Private multipliers:			
within province	16.7	–	11.4
within region	9.9	1.0	7.1
outside region	1.8	–	1.2
Other sources (LGUs, NGOs)	5.8	–	3.9

Table 14. Availability, price and use of genetically improved tilapia.

	Growout (% of farmers)					Hatchery (% of farmers)				
	GIFT/ GST	GET/ EXCEL	GMT	FaST	All strains	GIFT/ GST	GET/ EXCEL	YY	FaST	All strains
Do you obtain fish stock from the same source?										
Yes	90	68	76	76	78	100	90	81	88	89
No	10	32	24	24	22	-	10	19	12	11
Is the supply available anytime when needed?										
Yes	94	94	92	84	91	100	87	88	76	86
No	6	6	8	16	9	-	13	12	24	14
Are you satisfied with the price paid for your stock?										
Yes	84	98	94	92	92	83	90	69	76	84
No	16	2	6	8	8	17	10	31	24	16
Are you willing to try new strains if available?										
Yes	76	72	86	70	76	50	62	75	76	66
No	24	28	14	30	24	50	38	25	24	34

Responsible Transfer of Improved Tilapia Breeds

Activities involving releases or the commercial production of tilapia breeds may result in escapes into the environment and may negatively impact the aquatic biodiversity and the tilapia industry.

Awareness of tilapia genetics technology

This particular issue was related to the degree of awareness of the farmers regarding tilapia genetics technology (and their products) in general, and to R&D work in particular. Results of the study show that among growout farmers, only 40% of the respondents are aware of tilapia genetics technology compared to 83% among hatchery operators (Table 15). This could be due to the training which hatchery farmers are required to undergo in order to have access to the improved tilapia broodstock. Among growout farmers, it is likely that buyers/users come from areas not effectively reached by extension workers. Similar results were observed relative to farmers' awareness of tilapia genetics R&D work as shown in Table 16.

There are two significant findings which can be drawn from these survey results. First, government extension workers are not effective in terms of "educating" or providing information to growout farmers regarding tilapia genetics technology, but hatchery operators have more access to them. Second, private producers/farmers and institutional and individual suppliers of genetically improved tilapias could be tapped as effective disseminators of information.

Table 15. Number of farmers who are aware of tilapia genetics technology and main sources of information.

	Growout					Hatchery				
	GIFT/ GST	GET/ EXCEL	GMT	FaST	All strains	GIFT/ GST	GET/ EXCEL	YY	FaST	All strains
Degree of awareness: (% of farmers)										
Aware	42	28	46	42	40	83	82	88	82	83
Unaware	58	72	54	58	60	17	18	12	18	17
Sources of information:	**(% of responses)**					**(% of responses)**				
Fellow producers and farmers	28	20	20	58	34	–	33	14	31	28
Government extension workers	12	32	26	6	16	40	56	19	24	38
Technicians from source	31	26	30	16	26	20	7	33	31	20
Technicians/salespersons of feed companies	12	18	8	6	10	–	–	–	–	–
Media (radio, TV, print)	5	–	8	2	4	40	4	10	–	6
Others (friends, researchers)	12	4	8	12	10	–	–	24	14	8

Table 16. Awareness of R&D work in tilapia genetics.

Degree of awareness and sources of information	Growout (% of farmers)					Hatchery (% of farmers)				
	GIFT/ GST	GET/ EXCEL	GMT	FaST	All strains	GIFT/ GST	GET/ EXCEL	YY	FaST	All strains
Aware	44	30	46	40	40	100	75	88	88	81
Unaware	56	70	54	60	60	–	25	12	12	19
Sources of information:	**(% of responses)**					**(% of responses)**				
Government extension workers	20	29	20	29	23	6	35	24	22	28
Media (TV, radio, print)	10	9	4	9	7	6	2	3	7	4
During seminars, workshops, trainings	10	14	18	17	15	25	25	18	22	23
Fellow farmers	7	6	7	6	7	12	6	15	20	12
Traders	–	6	5	–	3	6	1	–	4	2
Fish buyers	2	11	11	11	9	6	3	3	4	4
Feed technicians	7	9	14	9	10	6	3	9	9	6
Suppliers of fingerlings	34	14	18	17	21	2	21	21	11	19
Others (friends, researchers, others)	10	3	2	3	4	6	2	6	–	3

Quality assurance

Economic sustainability of the breeding programs and seed quality are two of the major concerns of the industry. Certification of seeds helps ensure supply of high-quality fingerlings to growout farmers. It is also essential that awareness is built among stakeholders (pubic and private) of the properties, benefits and risks associated with genetically improved fish breeds.

Attitudes toward the use of genetically improved tilapia

With the development of various genetics-based technologies for tilapia culture, farmers become very involved with the technology by evaluating the relative advantages and economic attributes of the different products available. This occurs during the innovation-decision process "through which the farmers pass through from initial awareness of the technology to final adoption or rejection and confirmation of their decision". Thus, farmers develop a general perception, favorable or otherwise, about a particular strain of improved tilapia.

This rational behavior of technology adopters probably explains why 32-54% of growout farmers have used different stocks of improved tilapia (Table 17). It could be theorized that this group of farmers are more receptive to innovations, or are early users of improved tilapia. As such, they could be at the confirmation stage in the innovation-decision process where reinforcements of the decision made are being done. On the other hand, the other group of farmers who have not shifted to another strain could still be in the implementation stage, meaning that the product of the technology is just being adopted and put into use.

There are several reasons given by those who have shifted to other strains. Many of these reasons are biological, technical and economic in nature. However, as shown in the same table, a common reason given is the availability of new improved strain which enticed them to use the product. The other important reasons given were availability of new strains; poor growth; and unavailability when needed.

The survey results also illustrate the positive perception of majority of the producers of genetically improved tilapias (Table 18). In general, it is no longer difficult to obtain high-quality tilapia strains for hatchery and growout purposes, although a substantial number still agree that it is difficult to do so. Correspondingly, most of the farmers do not receive complaints about the quality of tilapia they produce. This assertion is backed up by their confidence that their products are comparable in quality with those produced by government-run farms and with those of other private operators.

Table 17. Reasons for changing attitudes on the use of improved tilapia strain.

	Growout				Hatchery			
	GIFT/ GST	GET/ EXCEL	GMT	FaST	GIFT/ GST	GET/ EXCEL	YY	FaST
Have you used a different stock from the one you currently use?	(% of farmers)							
Yes	32	48	54	54	100	31	31	35
No	68	52	46	46	–	69	69	65
Reasons for the change:	(% of responses)							
Poor growth	17	8	12	13	–	18	9	–
Low survival	9	12	17	4	–	8	–	–
Low fingerling production[1]	–	–	–	–	–	18	–	–
Declining fingerling demand[1]	–	–	–	–	–	10	18	–
Unavailability when needed	8	16	10	15	–	3	–	–
Availability of new improved breed/strain	14	12	15	16	–	18	10	25
High price	6	6	23	6	–	6	18	–
Distance of source	6	10	8	7	–	7	18	–
Difficult to grow/manage	6	6	10	4	–	8	9	–
Vulnerable to disease	4	8	2	4	–	–	18	–
Uneven size at harvest[2]	3	10	10	6	–	–	–	–
Unwanted reproduction[2]	4	10	3	3	–	–	–	–
For comparative testing/trial	9	–	–	10	–	1	–	25
For additional strains	14	–	7	9	–	3	–	25
Not profitable	–	2	–	–	–	–	–	–
For breeding	–	–	–	–	–	–	–	25

[1] For growout farmers only.
[2] For hatchery farmers only.

Table 18. Attitudes and perceptions of farmers about the quality of genetically improved tilapias produced in their farm.

Rating scale	Pond growout (%)	Hatchery (%)	All farmers (%)
It is difficult to obtain high-quality tilapia broodstock and fingerlings.			
0	-	-	-
1	3	3	3
2	36	34	35
3	54	63	57
4	8	-	5
5	-	-	-
Some of my buyers complain about the poor quality of my tilapia product.			
0	1	3	2
1	-	9	3
2	16	20	17
3	62	43	56
4	16	24	18
5	5	1	4
The quality of tilapia sold by other private operators is better than mine.			
0	1	1	1
1	-	2	1
2	12	6	10
3	65	56	62
4	1	28	17
5	11	7	9
The quality of tilapia sold by government-run hatcheries is better than mine.			
0	1	2	1
1	3	2	3
2	14	8	12
3	56	73	62
4	6	6	6
5	20	9	16

Rating scale:
0 – not applicable
1 – strongly agree
2 – agree
3 – disagree
4 – strongly disagree
5 – do not know

The Policy Challenge

The gains that have been achieved in the field of tilapia genetics research in Philippines are largely the result of successful partnerships between public and private sectors. The development of improved strains took many years and required substantial financial, material and human investments. Numerous technical breakthroughs were likewise required before the products were finally disseminated and commercialized.

With the current dynamic growth trend mainly brought about by the increasing interest to grow genetically improved tilapia, the industry faces many opportunities, as well as challenges and uncertainties. The issues and concerns relevant to the development of the Philippine tilapia industry, especially those which relate to the dissemination of research outputs, should be addressed and given focus. It is generally considered that the best way to achieve this is by “providing an environment that promotes stronger public and private sector partnerships”.

Appreciating the changing context of tilapia genetics research

There are external factors affecting genetics-based aquaculture R&D in Philippines and exerting pressure for change. Based on the experiences of the institutional developers of improved tilapia, these factors include: shrinking investments in public goods, growing private sector activities and participation, and changing legal and regulatory regimes.

There is an increasing emphasis on market mechanisms forcing government institutions to respond to expanding economic opportunities. Thus, government institutions, which primary mandate is to do R&D, become increasingly involved in production and marketing to generate revenues needed to sustain their genetics work. Such is the case of BFAR, the breeding center for GET-EXCEL tilapia. On the other hand, CLSU, the developer of YY/GMT and FaST, has adopted a unique and novel approach in implementing its tilapia genetics research program. A company operating as a private entity but still within the administrative supervision of the university, was set up to generate revenues to sustain the agency’s tilapia R&D work.

The growing activities of the private sector, including national and multinational companies, have given rise to concerns regarding technology transfer and providing products which address food availability, income generation, equity and sustainability. Based from pronouncements, however, the private sector does not intend to take over the role of the public sector in R&D. Instead, there was a consensus among the various stakeholders of the industry that public-private partnerships should be nurtured in order to disseminate more efficiently and effectively the products of tilapia genetics research to the farmers who are the final end-users.

It was also observed and adequately manifested that the dissemination of improved tilapia poses formidable challenges and complications. Foremost are issues and concerns surrounding management and ownership of intellectual property. The most important challenge which scientists, managers and policymakers must face is the need for capacity and competency in this area.

Taking advantage of the opportunities and challenges

The importance of genetics-based technology in tilapia farming is aptly illustrated by the successes gained by and the current dynamism of the Philippine tilapia industry. With this achievement, genetics R&D is recognized as critical in our struggle to reduce poverty and improve food security. However, it is equally important not to deny people access to new technologies. However, they should be fully informed of the benefits as well as of the potential risks, so they will be able to make their own decisions and choices.

The evolving public-private partnerships in the delivery of products of tilapia genetics research offer the following opportunities and challenges on the use of new technologies for the overall benefit of society.

1. Aggressive product promotion and proactive extension delivery systems will ensure that majority of the users of genetically improved tilapias regardless of their status and classifications are adequately served. This is where public-private sector partnerships can be fully harnessed to address the major issues and concerns regarding the production and dissemination of products of tilapia genetics research. The roles of various sectors or actors in the production-dissemination process, especially of the private sector, should be identified and their participation should be enhanced.

2. Efforts to allocate investments to support R&D activities should be intensified. Majority of the funding for such activities has been raised through novel income-generating projects and strategies. There should be increased public support in this area, but the private sector should equally share the burden of making sure that the gains which have been achieved are sustained.

3. Publicly supported breeding centers should recognize their responsibility to support the multipliers, local hatcheries and growout farmers. Innovative mechanisms and new modalities should be explored.

Reference

BFAR (Bureau of Fisheries and Aquatic Resources). 2001. 2000 Philippine fisheries profile. BFAR, Department of Agriculture, Quezon City, Philippines.

Generating Resources to Continue Tilapia Genetic Improvement Research and Development through Public-Private Sector Partnerships in the Philippines

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Abstract

In the 1980s and 1990s, three major tilapia genetic improvement projects were undertaken in Philippines. These projects were the: (1) Fish Genetics Project, (2) Genetic Improvement of Farmed Tilapia (GIFT) Project and (3) Genetic Manipulations for the Improvement of Tilapia (GMIT) Project. All these projects were funded by international donor agencies. When grant funding for these projects ended, the institutions involved in the work adopted a number of strategies to generate the funding required to continue the programs.

This paper looks into the various strategies adopted by the institutions with a special focus on the resulting public and private sector partnership models. The paper discusses the successes as well as the shortcomings of the various models that have emerged for the tilapia seedstock industry in Philippines. A brief review of post-project investments made by the institutions is also provided.

As a result of the Philippine experience in generating resources for the continuation of tilapia genetic improvement research, the paper highlights several issues and concerns and makes a number of recommendations regarding public and private sector partnerships.

Background

In the 1980s, three tilapia genetic improvement projects were initiated in the Science City of Muñoz, Nueva Ecija, Philippines. These three projects were the: Fish Genetics Project, GIFT Project and GMIT Project. These projects have spawned at least five continuing genetic improvement efforts in Philippines as shown in Table 1.

Additional lines are expected to come out of these efforts in the coming years. The active tilapia breeding institutes or organizations in Philippines are the:

- National Freshwater Fisheries Technology Center of the Bureau of Fisheries and Aquatic Resources (NFFTC/BFAR);
- Freshwater Aquaculture Center of the Central Luzon State University (FAC/CLSU); and
- GIFT Foundation International, Inc. (GFII) (on its own and in collaboration with GenoMar ASA of Norway).

The termination of grants for the GMIT Project (Overseas Development Administration) and the Fish Genetics Project (International Development Research Centre), however, has resulted in the establishment of Phil-Fishgen (a collaborative project among FAC/CLSU, University of Wales Swansea [UWS] and Fishgen Ltd.) and the FaST Project (internal to FAC/CLSU). The termination of the GIFT Project has resulted in the establishment of GFII (by the institutional partners of the GIFT Project) and the National Tilapia Breeding Program of NFFTC/BFAR. The fifth breeding institution is GenoMar ASA, a private company with the GIFT Foundation as a small shareholder. In Philippines, GenoMar ASA is represented by its subsidiary GenoMar Supreme Philippines, Inc.

Table 1. Three major tilapia genetics projects undertaken in and among Tilapia Science Center institutions.

Project/duration	Institutions involved	Donor(s)	Strain/brand
Fish Genetics Project (1986-1998)	FAC/CLSU	IDRC-Canada	FaST (also called "IDRC" strain in the local market) produced by hatcheries which purchase broodstock from FAC GET EXCEL (see description below)
GMIT (1989-1995)	FAC/CLSU UWS	ODA, now called the Department for International Development (DFID) of UK	GMT (sometimes called "YY") produced by Fishgen Ltd. and by Phil-Fishgen and its accredited hatcheries in Philippines
GIFT (1988-1997)	FAC/CLSU NFFTC/BFAR International Center for Living Aquatic Resources Management (ICLARM, now the WorldFish Center) Institute of Aquaculture Research (AKVAFORSK) of Norway Marine Science Institute of the University of the Philippines (UPMSI)	Asian Development Bank (ADB) United Nations Development Programme, Division of Global and Interregional Programmes (UNDP/DGIP)	GET EXCEL (formerly GET, BFAR 2000) produced by NFFTC and its accredited multipliers BFAR lines for saline and cold tolerance GIFT Super Tilapia, formerly produced by GFII and its licensed hatcheries (commercial distribution has been suspended in favor of GenoMar Supreme Tilapia) GFII research nucleus GenoMar Supreme Tilapia produced by GenoMar Supreme Philippines and its partner hatcheries in Philippines

In an attempt to illustrate the flow of germplasm as well as the institutions involved, a family tree of these genetic improvement efforts in the Philippines is illustrated in Figure 1.

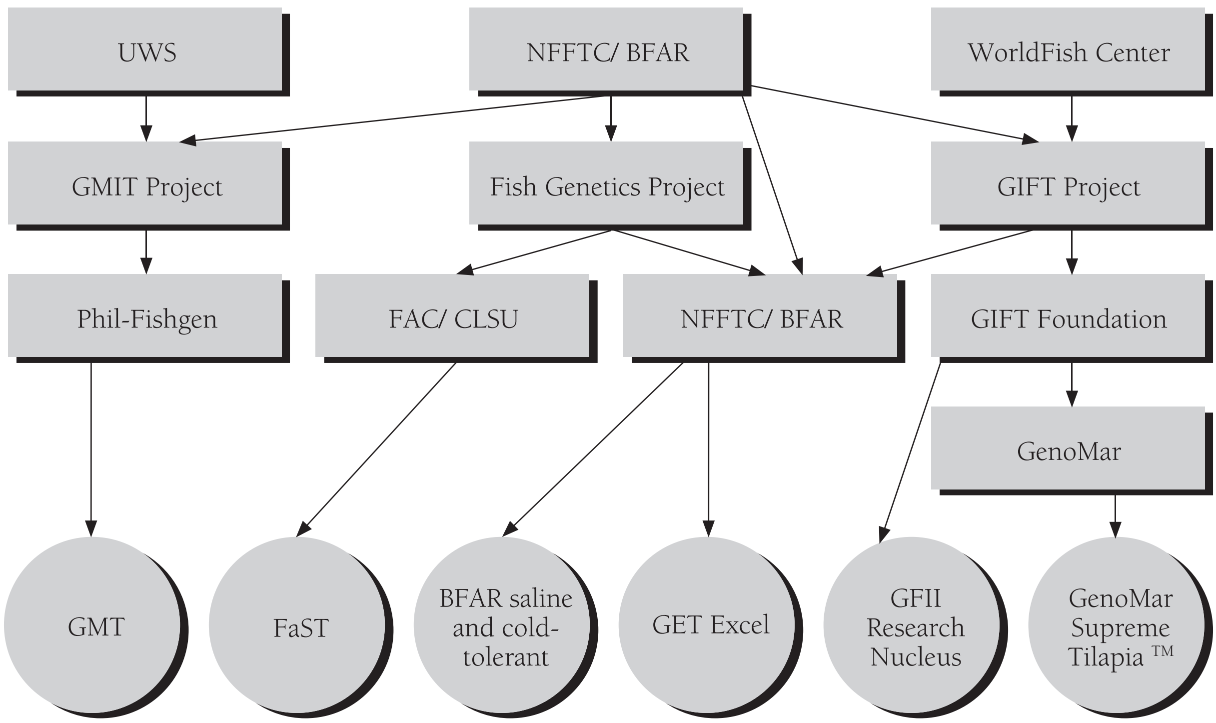

Figure 1. "Family tree" of tilapia genetic improvement projects in Philippines.

The different strains maintained and distributed in Philippines by these institutions are also presented in Figure 1 and Table 1.

This paper has been prepared from the investigations conducted as part of the project entitled "Public-private Partnerships on Fish Genetic Research: the Philippine Experience". The project was a collaborative effort between the WorldFish Center and the institutions of the Tilapia Science Center (TSC) (NFFTC/BFAR, FAC/CLSU and GIFT Foundation) and was funded by IDRC of Canada. Activities of the specific project component from which this paper was written were focused on the following:

1. reviewing the manner in which institutions involved in TSC obtain the resources they need to conduct tilapia genetic improvement research and development (R&D);
2. how partnerships with the private sector are utilized to generate resources; and
3. the impact of these partnerships on the funding and resources available in Philippines for tilapia genetic improvement R&D.

Obtaining Resources for Genetic Improvement Research

A review of past and present tilapia genetic improvement research in Philippines has resulted in the identification of a number of R&D resource generation models. Institutions have been able to directly or indirectly obtain/generate resources for genetic improvement R&D. Resources are generated directly through grants or allocation of government operating budgets. Indirect methods of generating resources include commercial activities (i.e., selling seedstock) and entering into partnering arrangements with the private sector through new entities organized for this purpose.

From grants

Grants, as shown in Table 1, have been the traditional source of funding for tilapia genetic improvement research projects. Grants can be provided by donor agencies/organizations from the public sector as well as from the private sector. These beneficiaries of such grants can be public institutions (i.e., government agencies, state colleges and universities), private entities (i.e., nongovernment organizations, private colleges and universities, associations, etc.) or collaborative activities between public and private entities. Purely private entities, particularly if they are for-profit, normally do not have access to such funding.

Although multilateral and bilateral grants coming from international donor agencies for genetic improvement research have expired, NFFTC and FAC/CLSU have been able to obtain grants for its work in the development of a saline-tolerant strain from Philippine government sources (DA-BFAR). GenoMar ASA, though a private for-profit corporation, has also been able to obtain grant funding from the Norwegian government for R&D activities it is undertaking in Philippines.

From government budgets

Under this funding model, resources required for the genetic improvement R&D activities are obtained totally from government budget allocations. These allocations can be made directly (e.g., budgets to cover operating expenses) to the institution undertaking the genetic improvement work or via a grant to a specific project within an institution.

Falling under this model is the tilapia breeding program of NFFTC/BFAR (GET BFAR 2000 and GET EXCEL). The NFFTC undertakes the selective breeding activities fully within its annual budget. Although the institute generates a fair amount of revenues from the sale of tilapia fingerlings and breeders, it is not dependent on these revenues to fund R&D activities. Under existing government rules and regulations, proceeds from NFFTC's sales are remitted directly to the National Treasury.

Although FAC/CLSU's R&D activities for FaST and GMT strains also benefit from some budget allocations within the university, these only cover part of the total resources needed for the project. The projects generate additional resources for R&D through its "business" activities (i.e., broodstock and/or fingerling sales).

From sales and other "business" revenue from science assets

A number of the Philippine breeding institutions fund their R&D efforts wholly or partially from the revenues they generate from the sale of fingerlings, breeders and/or fish and other business or commercial endeavors. Although these are normal and expected activities for companies organized to generate profits, nonprofit organizations have, in recent years, resorted to such "business" activities in order to generate resources to fund their programs.

The breeding institutions that wholly or partially rely on sales and other related revenue to fund R&D activities are the: FaST and Phil-Fishgen Projects of FAC, GFII and GenoMar ASA (see Table 2).

Table 2. Types of revenue generated by the different tilapia-breeding institutions.

Type of revenue	Phil-Fishgen	FAC FaST Project	GIFT Foundation	GenoMar
Fingerling sales	√		√	√
Charges for use of breeders	√		√	√
Breeder sales	√	√	√	√
Fish sales			√	√
Charges for services			√	√
Dividends from investments			√	√

As an institute within a university, FAC has been able to generate revenues, outside grants and budget allocations, by allowing the projects it has established for genetic improvement R&D to retain and use proceeds from the sale of breeders and/or fingerlings. In Philippines, state colleges and universities are allowed to undertake income-generating activities and retain the resources generated from these activities for their own use.

The GFII is a nonprofit, nonstock corporation which founding members are the GIFT Project collaborating institutions – BFAR, CLSU and the WorldFish Center. As an entity with a legal personality distinct from its founders, the GIFT Foundation has the ability to enter into arrangements, agreements and/or contracts with private entities to generate resources for R&D through "business" activities.

From private sector contributions

Direct private sector contributions to genetic improvement R&D can take the following general forms – (1) membership fees/dues in and contributions to nonstock, nonprofit organizations engaged in genetic improvement and (2) investments (i.e., purchase of shares of stock) in for-profit companies engaged in the business of genetic improvement. However, for as long as the membership or ownership of these organizations remains predominantly public sector and their funding sources and governance structures do not involve significant private sector participation, such organizations should be considered more public sector than private sector.

The GFII represents the nonstock, nonprofit model. Although membership in the foundation has thus far been limited to BFAR, CLSU, WorldFish Center and a few private individuals with ties to the founding members, the membership rules of the foundation allow other public and private entities, individuals and organizations, to seek membership in it. Membership will require these private entities to make contributions, in cash or in kind, to the work of the foundation. At present, however, there are no private sector contributions to the foundation due to the absence of private sector members.

As a stock corporation, GenoMar is capable of generating resources for R&D by raising capital for this purpose as well as allocating a portion of its operating profits and/or retained earnings. GenoMar ASA is majority-owned by private sector individuals and groups thus making it the only truly privately owned breeding institute among those operating in Philippines today.

Table 3 summarizes the resource generation options, existing and potential, available to existing breeding institutions.

Table 3. Resource generation options available to existing tilapia-breeding institutions.

	NFFTC	FAC	Phil-Fishgen	GIFT Foundation	Geno-Mar
Grants	√√	√	√√	√	√√
Government budget	√√	√√			
Business					
Fingerling sales	*	√	√√	√√	√√
Breeder sales	*	√√	√√	√√	√√
Breeder use charges	*	√	√√	√√	√√
Other charges				√√	√
Investments				√	√√
Private sector					
Membership contributions				√	
Equity investments					√√

√√ = current √= potential *= possible if rules regarding retention of sales proceeds are amended.

Public-private Sector Partnerships and Their Impact on the Level of Funding/ Expenses for R&D

All breeding institutions in Philippines involve the private sector in the dissemination of genetically improved seedstock. Most current partnerships with the private sector are focused on dissemination – an activity that also provides the institutes with the business opportunities to generate resources for R&D.

Dissemination partnerships between private and public sectors are based on the use by private hatchery operators of broodstock provided by the breeding institutes in the production of seedstock for sale. The partnership models utilized in Philippines include simple broodstock sales, accreditation programs and licensing agreements. A number of joint venture possibilities in multiplication and distribution of seedstock in Philippines have been considered but none have materialized thus far. Internationally, GenoMar ASA has also been working with private sector partners, under a variety of arrangements, to multiply and produce genetically improved seedstock.

Under most partnership arrangements established for the distribution of improved seedstock, private sector partners remain uninvolved in actual genetic improvement R&D. However, an example of a partnership where the private sector partner is directly involved in the actual R&D activities is the partnership between the GIFT Foundation and GenoMar ASA. In essence, the partnership has three elements:

1. an equity partnership in which the GIFT Foundation obtained shares of stocks in GenoMar in exchange for fish and other commercial arrangements in Philippines;
2. a service contract partnership in which GenoMar contracts the foundation to perform breeding services; and
3. a distribution partnership in which GenoMar and the foundation have agreed to enter into a joint venture or other arrangements for the distribution of the seedstock in Philippines.

In this relationship, GenoMar, as a biotechnology company, bears technical responsibility for R&D activities. GenoMar scientists in Norway finalize breeding models and plans and instructions are provided to GIFT Foundation staff who conduct the breeding work in Philippines. All costs of the planning, analysis and breeding activities in both Norway and Philippines are borne by GenoMar. Although the GIFT Foundation has this relationship with GenoMar, it also maintains its own independent breeding nucleus. R&D on this nucleus is funded from the resources that the foundation generates from its other activities. Under its agreement with GenoMar, the foundation is allowed to conduct its own research independent from GenoMar provided that GenoMar is informed of and invited to participate in such research. If interested in participating in the foundation's research, GenoMar and the foundation have to discuss and agree on the terms of participation and ownership of expected intellectual property prior to undertaking the research activities.

All these partnerships, either in distribution or in R&D, have contributed to making more resources available for genetic improvement R&D activities. Without these partnerships, some of the genetic R&D improvement efforts may have been discontinued at or shortly after the expiration of the grants.

Information on resources generated and expenses incurred as reported by the breeding institutions are summarized below:

1. FAC/CLSU reported that it has spent on the FaST Project a total of PhP1.09 million from 1999 to 2003. These are direct expenses that are not included in the center's budgets but are taken out of FaST sales. FaST sales for the same period have amounted to PhP1.58 million (approximately US$20,691). The expenses reflected for the project do not include electricity, facilities, fees for scientist and technical staff and some farm labor expenses since these are covered by the institutional budgets. Table 4 presents a summary of the annual expenses and sales revenue of the project between 1999 and 2003.

Table 4. Revenues and direct expenses, FaST Project (in PhP'000)[a].

	1999	2000	2001	2002	2003
Revenues					
Breeder sales	240.4	270.5	345.4	274.1	296.8
Donations	0.0	0.0	7.5	40.0	51.0
Others	7.5	7.5	7.5	20.0	15.0
Total revenues	247.9	278.0	360.4	334.1	362.8
Direct expenses					
Personnel	0.0	25.0	40.6	87.9	47.0
Travel	8.6	6.5	8.1	5.5	1.9
Supplies and materials	39.9	148.8	145.0	285.0	126.9
Repair and maintenance	11.1	17.2	13.7	0.0	11.5
Others	7.2	11.3	15.3	22.5	6.6
Total direct expenses	66.8	208.8	222.7	400.9	194.0
Surplus (shortfall)	181.1	69.2	137.7	(66.8)	168.8

[a] In January 2004: US$1 = PhP55.

Table 5. Revenues and direct expenses, Phil-Fishgen (PhP'000).

	1995	1996	1997	1998	1999	2000	2001	2002
Revenues								
Fingerlings	120.3	188.4	412.1	616.1	1,452.8	2,211.4	1,927.0	2,447.9
Breeders	784.6	579.0	631.8	333.4	1,148.4	1,007.6	1,065.0	952.0
Others	5.8	35.8	59.4	284.5	317.1	115.6	299.5	239.5
Total revenues	910.7	803.2	1,103.3	1,234.0	2,918.3	3,334.6	3,291.5	3,639.4
Direct expenses								
Personnel	10.8	124.4	177.4	283.8	482.2	648.8	1,017.9	1,222.0
Travel	7.5	32.4	29.7	30.5	82.3	74.5	111.4	86.9
Supplies and materials	181.6	297.8	351.7	336.6	611.7	765.3	1,090.1	1,319.9
Facilities	86.3	92.1	62.2	67.4	60.2	117.9	154.5	112.5
Equipment	5.5	63.9	26.9	38.1	40.7	61.7	84.4	79.5
Direct expenses	291.7	610.7	647.9	756.4	1,277.1	1,668.2	2,458.3	2,820.8
Surplus (shortfall)	619.0	192.5	455.4	477.6	1,641.2	1,666.4	833.2	818.6

Phil-Fishgen's policy, as embodied in the Memorandum of Agreement between CLSU and UWS, for handling annual surpluses is as follows:

- 50% to be remitted to DFID to be used for research grants (which Phil-Fishgen can apply for);
- 15% to be used for information dissemination (e.g., printing of educational materials); 2% to be carried over to the following year's operating budget; and
- 33% to be shared by project-hired management and staff as well as FAC/CLSU and UWS staff involved in the project.

2. Phil-Fishgen reported that total direct expenses for the eight years between 1995 and 2002 amounted to PhP10.5 million. For the same period, total sales revenues of GMT® amounted to PhP17.235 million. As in the case of FaST, direct expenses as reported do not include electricity, facilities, fees for scientist and technical staff, and some farm labor expenses that are covered by FAC from other budgets. In addition, the reported figure includes expenses incurred by Phil-Fishgen for fingerling/breeder production and distribution. The Phil-Fishgen manager estimated that expenses incurred for genetic improvement R&D amount to approximately 25% of Phil-Fishgen's total expenses. The rest of the expenses are incurred for fingerling production and distribution. Table 5 presents the annual summary of Phil-Fishgen's revenues and direct expenses.

3. The GIFT Foundation's operating revenues have, since 1998, come primarily from fingerling sales and fees earned from its hatchery licensing program. The foundation has also earned some grant service income over the years. Total revenues from 1998 to 2002 amount to about PhP64.4 million. Total operating expenses, including depreciation, amounted to PhP63.0 million for the same period.

   The foundation is carrying the value of the GIFT breeding nucleus on its books (booked as members' in-kind contribution when the foundation was founded). This value is depreciated over the useful life (i.e., three years) of the fish collection. Depreciation and mortality costs are charged against the development costs of the subsequent generation, for breeders used in the selective breeding experiments, and as a cost of producing commercial breeders. The development costs incurred for each generation are capitalized and depreciation of the new generation starts once the selection process for the breeders of the new generation is completed.

   The expenses reflected in the revenue and expense summaries shown in Table 6 include the expenses incurred by the foundation for the contracted breeding services provided to GenoMar. GenoMar pays the foundation approximately PhP5.5 million per year for these contracted services. These payments cover direct expenses for supplies, staff time, contracted labor and travel as well as indirect expenses.

GenoMar receives grant funding from the Norwegian government to cover a significant portion of the costs of these services contracted from the foundation. GenoMar's R&D expenses for genetic improvement go beyond what they pay the foundation for the contracted activities. Their financial statements for 2002 indicate total company expenses of approximately NOK17 million (about US$2.5 million) of which over 42% or NOK7.2 million was spent for R&D. In fact, the company's books treat grants and other government payments (NOK 3.2 million in 2002) obtained from the government as a "cost reduction". The company's notes to their 2002 financial statements show that direct expenses for tilapia genetics R&D amounted to 24% or

Table 6. Operating revenues and expenses, GIFT Foundation (PhP'000).

	1998	1999	2000	2001	2002
Revenues	9,919.6	9,953.4	12,554.6	15,042.6	16,911.0
Expenses					
Personnel	3,097.7	4,680.2	6,512.4	7,441.0	9,581.0
Supplies and services	1,336.7	2,029.1	2,739.3	4,521.9	5,822.5
Travel	253.3	317.4	729.0	603.7	853.1
Others	177.9	175.8	168.9	32.5	129.3
Depreciation	6,409.7	2,224.7	2,907.8	121.7	137.9
Total expenses	11,275.3	9,427.2	13,057.4	12,720.8	16,523.8
Surplus (shortfall)	(1,355.7)	526.2	(502.8)	2,321.8	387.2

NOK1.7 million (US$253,000) of their total R&D investments. The Norwegian government's subsidy for tilapia genetics R&D amounted to NOK316,490 for 2002. The significant contribution made by the Norwegian government to the costs of GenoMar's research is a clear example, though not from Philippines, of public-private sector partnerships. In fact, Norfund, a Norwegian government agency, owns about 8% of GenoMar's equity.

The foundation spends approximately PhP15.0 million per year (inclusive of depreciation of the breeding nucleus) for the maintenance and selective breeding of its own breeding nucleus. Without depreciation, it spends approximately PhP1.0 million per year for the direct expenses for this activity. Needless to say, the foundation's investments in R&D are dependent on the cash flows generated from its "business" activities.

4. NFFTC/BFAR's expenses for genetic improvement R&D since 1998 are presented in Table 7. Annual expenses in genetic improvement R&D have been at the PhP5.0 million level for all three genetic improvement initiatives being undertaken by NFFTC. This level represents the resources provided to genetic improvement R&D out of the institution's standard operating budget. The center has, however, benefited from some grants for these R&D activities, and it appears that these grants influence the extent to which annual R&D expenses exceed PhP5.0 million. In 2002, the center received a grant of PhP5.3 million for the refurbishment of the Regional Outreach Stations serving as the primary multipliers for the GET EXCEL dissemination program. Prior to 2002, NFFTC received a grant from the Bureau of Agricultural Research (BAR) for the development of salt-tolerant tilapias.

Table 7. Research development costs for improved tilapia, NFFTC/BFAR (in PhP'000).

	1998	1999	2000	2001	2002
GET-EXCEL					
Personnel	164.0	164.0	202.1	229.8	229.8
Labor cost	416.2	433.9	372.1	367.6	316.8
Travel	28.5	33.4	24.0	50.8	60.5
Equipment	125.0	220.0	180.0	185.0	260.0
Supplies and materials	950.0	963.0	942.5	900.0	600.0
Repair and maintenance	32.1	33.5	35.0	36.4	60.0
Others	90.0	42.0	90.0	235.0	5,524.0
Subtotal	**1,805.8**	**1,889.8**	**1,845.7**	**2,004.6**	**7,051.1**
Onfarm counterpart	**0.0**	**20.5**	**25.0**	**25.0**	**25.0**
Total (GET)	**1,805.8**	**1,910.3**	**1,870.7**	**2,029.6**	**7,076.1**

Table 7 (cont.)

Table 7 (cont.)

	1998	1999	2000	2001	2002
Saline-tolerant strain					
Personnel	273.1	273.1	311.2	356.8	356.8
Labor cost	416.2	433.9	372.1	367.6	316.8
Travel	35.0	84.0	250.0	27.8	30.2
Equipment	100.0	120.0	100.0	80.0	110.0
Supplies and materials	990.0	460.0	900.5	750.0	576.9
Repair and maintenance	52.1	45.0	95.0	21.5	40.0
Others	130.0	62.0	95.2	125.0	224.0
Subtotal	**1,996.4**	**1,478.0**	**2,124.0**	**1,728.7**	**1,654.7**
Onfarm counterpart	**0.0**	**280.0**	**180.0**	**150.0**	**150.0**
FAC counterpart	**0.0**	**616.3**	**1,419.5**	**0.0**	**682.2**
Total (saline)	**1,996.4**	**2,374.3**	**3,723.5**	**1,878.7**	**4,365.6**
Cold-tolerant strain					
Personnel	164.0	164.0	202.1	229.7	229.7
Labor cost	416.2	433.9	372.1	367.6	316.8
Travel	32.0	67.0	29.0	25.0	28.5
Equipment	75.0	80.0	75.0	60.0	80.0
Supplies and materials	950.0	850.0	692.5	710.0	476.6
Repair and maintenance	22.2	17.0	25.0	28.0	20.5
Others	90.0	22.5	38.2	125.0	220.0
Subtotal	**1,749.4**	**1,634.4**	**1,433.9**	**1,545.3**	**1,372.1**
Onfarm counterpart	**0.0**	**20.0**	**20.5**	**20.5**	**20.5**
Total (cold)	**1,749.4**	**1,654.4**	**1,454.4**	**1,565.8**	**1,392.6**
Total NFFTC	**5,551.6**	**5,002.2**	**5,403.6**	**5,278.6**	**10,077.9**
Total counterpart	**0.0**	**936.8**	**1,624.5**	**195.5**	**877.7**
Total genetic improvement	**5,551.6**	**5,939.0**	**7,028.1**	**5,474.1**	**10,955.6**

Notes:
1. FAC counterpart contributions were funded by a grant from DA-BAR.
2. A portion of NFFTC's expenses for the development of the saline-tolerant strain was funded by a grant from DA-BAR.
3. PhP5.3 million of GET development expenses for 2002 was obtained from a special government grant and was used to upgrade the facilities of the Regional Outreach Stations to prepare them for the dissemination of GET EXCEL.
4. "Onfarm counterparts" are the in-kind contributions made by farmer-cooperators participating in the onfarm testing of the improved strains.

The above report does not include an allocation, to the cost of R&D activities, of the NFFTC's various overhead expenses such as electricity, administrative costs and others.

NFFTC continues to distribute a significant number of fingerlings and breeders out of its facilities in Muñoz Science City, Nueva Ecija. The highest level of sales revenue was recorded in 2001 when the center sold PhP6.7 million worth of fingerlings and PhP1.6 million worth of breeders. The facility can produce about 50-60 million tilapia fingerlings and about 2-3 million breeders annually. A significant portion of this production is distributed free of charge.

A review of the reports provided by the breeding institutions has led to the following observations:

- Most genetic improvement projects would probably not have been continued had the institutions not been able to generate revenues from fingerling and breeder sales. The only exception is NFFTC's GET Excel Program which continues to be a priority project of BFAR funded by the national government independent of the project's ability to generate revenues.
- The methods utilized by the research institutions to generate resources from the private sector for R&D in genetic improvement are varied and, to a large extent, tailored to each institution's particular circumstances.
- There is no one "best way" given the varied circumstances of the institutions. However, there may be ways to improve the individual institutions' ability to generate resources for R&D and to encourage private sector participation in the genetic improvement R&D effort.

- Institutions that rely on sales revenue to fund R&D activities need to be involved in tilapia fingerling production and distribution in order to generate the revenues they need. At present, the market prices for tilapia fingerlings allow hatcheries to make reasonable margins on the fingerlings – thus providing breeding institutions with profits they can plow back into research or to request hatcheries to share with them (usually in exchange for breeders or use of breeders) for continued R&D purposes.
- Public research institutions do not have the necessary policy framework and implementing guidelines to involve the private sector in collaborative R&D except through the sale of products.
- Most research institutions in the group are aware of the costs, especially on an annual basis of their research and related activities. However, systems to track and monitor accumulated "investments" in specific technologies (i.e., new breeds/strains) are often not in place. In some instances, research expenses, and therefore costs of technology, are not kept separate from other activities such as training, information dissemination and publications.
- All institutions, with the exception of the GIFT Foundation and GenoMar, do not carry on their books, the value of their broodstock.
- Only the GIFT Foundation seems to have a policy on capitalizing R&D expenses incurred for the genetic improvement effort.

Private Sector Participation in the Tilapia Seedstock Industry

In the case of tilapia genetic improvement, public sector institutions with funding support from international donor agencies initiated the research because tilapias were seen as a suitable species for smallholder aquaculture and thus could play an important role in providing opportunities for additional nutrition and income for the rural poor. Private sector interest was not present in the beginning because scientific and technical groundwork for tilapia genetic improvement was still necessary (thus making genetic improvement R&D seem highly risky), Philippines had little capability, in terms of facilities, scientists and technology, in fish genetic improvement R&D, and the market for tilapia seedstock was considered small.

Over the years, the industry situation has changed as follows:

- The importance of tilapia, as a food commodity, has grown not only domestically but also internationally.
- Tilapia farming has been growing not only in terms of farmed area but also in terms of farming intensity.
- The demand for tilapia seedstock grew significantly.
- The quality of seedstock has been improving due to genetic improvement programs and improvements in hatchery technology.
- The capability to undertake genetic improvement R&D within the country has been improving.
- The genetic improvement programs have demonstrated significant impact on the industry.

As a result of these industry trends, private sector interest in the tilapia hatchery business in Philippines has grown. In 1992, the Philippine Bureau of Agricultural Statistics (BAS) conducted a national census of hatchery owners. This census listed 206 hatcheries in Luzon out of about 250 hatcheries in the entire country. A sample of the Luzon hatcheries was surveyed by ICLARM (at present, the WorldFish Center) and BAS in 1994 with the following results highlighted in the project's final report (ICLARM 1998).

- average size of land used for the hatchery was 1.07 ha;
- average age of owner was 52;
- average number of years in the business was 10;
- most (72%) did not have any training in hatchery operations;
- majority (57%) used the fry collection in pond system;
- average investment per hectare was about PhP1.1 million;
- average production was 748,000 fingerlings per production cycle per hectare; and
- average selling price of fingerlings was PhP0.24 each with an average cost of production at PhP0.09 each.

In September 2003, a number of meetings were held in various regions across Philippines in preparation for the Second Tilapia Congress. In each of the regions, the BFAR Regional Directors presented a status report on tilapia aquaculture. Table 8 lists statistics on tilapia hatcheries presented in the meetings.

Table 8. Tilapia hatcheries statistics as presented in BFAR Regional Directors' status reports on tilapia aquaculture.

Location	Number of hatcheries	Average area per hatchery	Annual fingerling production (pieces)
Region 3: Central Luzon	142	2.13 ha	None reported
Region 4: Southern Tagalog	172	None reported	898 million
Region 2: Northeastern Luzon	128	0.6 ha	86 million
Region 12: Autonomous Region of Muslim Mindanao	107	0.87 ha	587 million

The number of tilapia hatcheries has increased significantly since the 1992 census. In the four regions (representing the bulk of tilapia production in Philippines) that provided hatchery statistics during the pre-congress meetings, the number of tilapia hatcheries was 549. It is realistic to estimate the present total number of hatcheries in the entire Philippines to be more than 600. Other analysts in the industry estimate that there are more.

Other observations which serve to illustrate the shift in private sector business interest in the tilapia hatchery industry are as follows:

- Average land area occupied by the hatcheries may still be at around the 1.0 ha level. However, average land area for hatcheries is larger in Central Luzon at 2.13 ha. Meanwhile the averages for individual Central Luzon provinces are: Nueva Ecija – 3.88 ha, Tarlac – 2.97 ha and Pampanga – 2.2 ha.
- The late 1990s witnessed the establishment of several large tilapia hatcheries with land areas of over 5 ha and production capacities in excess of 4 million fingerlings per month.
- Hatcheries have also started intensifying their operations using egg collection and artificial incubation systems.
- The total investments made in some of these intensive hatcheries are in excess of PhP10 million.
- Although the cost to produce one fingerling (standard size 22) in these intensive hatcheries may be in the range of PhP0.15-0.18, selling prices in some areas are above PhP0.40.

The significant growth of the tilapia farming sector in the 1990s fueled the growth of the market for tilapia aquaculture inputs, including tilapia seedstock. This is the primary reason why private sector participation in the multiplication and distribution of tilapia seedstock grew so dramatically and the breeding institutions' efforts to recruit private hatcheries as multipliers have been so successful.

Unfortunately, the private sector has, for the most part, been involved only at the technology application level (i.e., hatchery operations) and, with the exception of GenoMar, has not yet moved aggressively into breeding research. However, given the observed decline in public sector financing of agricultural research in developing countries and the declining importance of tilapia genetic research relative to other pressing industry/country needs and concerns, it is imperative to encourage the private sector to invest in R&D and technology transfer.

Pray and Fugile (2001) contend that investments by the profit-maximizing firms in agricultural research is a function of four main determinants – market size, appropriateness, technology opportunity and the cost of research inputs. They state that technology opportunity and the cost of research inputs are, in turn, primarily functions of public investments in research and higher education since these investments in basic agricultural sciences and precommercial technology expand opportunities for applied R&D by the private sector.

Table 9 describes the various incentives or disincentives to private sector investments in tilapia genetic improvement R&D in Philippines, classified according to the four determinants identified by Pray and Fugile (2001).

Recommendations

1. **All sectors within the Philippine tilapia industry should work on establishing a strong foundation for the industry's continued and sustainable growth.**

   Private sector interest in investing in R&D will depend primarily on the industry's prospects for strong sustainable growth. Good industry prospects will encourage the private sector to invest in R&D directed at developing and supplying improved inputs, including faster-growing and better-performing tilapia seedstock, to farmers. In the case of Philippines, for example, continued industry growth will depend on a number of diverse factors such as:

- the use of environmentally sound production practices;
- the ability of the government to enforce environmental laws;

Table 9. Incentives or disincentives to private sector investments in tilapia genetic improvement R&D in the Philippines.

Factor	Incentive	Disincentive
Size of market	The Philippines is one of the top tilapia-producing countries (i.e., fourth overall in 2000). Production volume has been growing and with it, demand for tilapia fingerlings.	Supply sometimes exceeds demand during certain times of the year. There is a need to strengthen extension programs so farmers will appreciate opportunities offered by genetic improvement R&D.
Appropriateness	There is positive farmer response to branding of tilapia fingerlings.	Full technical protection (i.e., sterility, protective hybridization) from genetic piracy is still not developed. Laws and mechanisms to protect breeders' rights are inadequate.
Technological opportunity	There are no restrictions on the introduction of new strains.	There is actual or perceived competition of public institutions with private sector.
Cost of research inputs	There are previous and ongoing publicly funded research projects in tilapia genetic improvement. There is a number of public breeding institutions with breeding materials, trained scientists/staff and breeding methodologies/protocols. There are investment incentives for private breeding companies.	There are no clear policies and mechanisms for public breeding institutions to provide parties from the private sector with access, exclusive or nonexclusive, to breeding materials, technical support and other technology. There are no policies that encourage partnerships between public research institutions and private sector. Laboratories and facilities for advanced biotechnology research are lacking. There is no funding and other support (i.e., credit) for private sector R&D initiatives. There are funding constraints on public research.

- a restructuring of the marketing and distribution systems;
- improved infrastructure;
- continued research and extension; and
- others.

2. **Government agencies, research institutes and input suppliers, including breeding institutes and their distribution partners, should improve the delivery of information and extension services to farmers.**

   One of the continued glaring weaknesses of the Philippine tilapia industry is the poor delivery of extension and training services to farmers. In fact, in various consultation meetings with farmers and other stakeholders, this need continues to be listed as important. Although much can be done to improve the delivery of these services by government agencies and institutions, the private sector, particularly the input suppliers, should continue their efforts to provide farmers with technical assistance and support.

   The delivery of extension services to farmers helps support the sustainable growth of the tilapia industry by allowing farmers to receive technology updates that would lead to improving productivity and/or reducing costs of production.

3. Continue to review international trends in legislation to protect intellectual property rights in fish breeding and consider their applicability to Philippines.

Duvick (1988) argues that the nature of private business (and therefore the basis for private sector investments in genetic improvement R&D) requires "that companies be allowed to own or license their stock in trade (their inbreds, hybrids and/or varieties) and, whenever possible, the processes, genes or plant parts that make their lines unique and hopefully superior to the competition." He reports that a body of laws and customs protecting plant breeders' rights has evolved in industrial countries with highly developed private seed businesses. Although progress in the protection of intellectual property in livestock and fish breeding is not as advanced as in plant breeding, the already existing laws and customs on plant breeders' rights can serve to establish useful precedents and conceptual frameworks.

In Philippines, for example, Section 22 of the Philippines' Intellectual Property Code (Anon. 2004) lists, as a nonpatentable invention, plant varieties or animal breeds as follows:

> "Section 22.4. Plant varieties or animal breeds or essentially biological process for the production of plants or animals. This provision shall not apply to micro-organisms and non-biological and microbiological processes.
>
> "Provisions under this subsection shall not preclude Congress to consider the enactment of a law providing *sui generis* protection of plant varieties and animal breeds and a system of community intellectual rights protection;"

Of course, some quarters view intellectual property protection as favoring transnational biotechnology companies and fear that such protection would make seedstock too expensive for a majority of farmers. It cannot be denied, however, that the absence of some laws and systems to enforce such laws on intellectual property protection will also result in making such products with the potential to improve farmer yields and/or margins not available to farmers.

In the absence of a legal framework to protect fish breeders' rights, breeding institutions/companies can look at developing built-in protection systems for their stock or the government can implement a seed certification system that would provide breeders with some degree of appropriateness. These options are discussed below.

The issue of breeders' rights has been a global topic of discussion for many years now and will continue in the years to come as new methods, tools and technologies are developed. Public and private sector stakeholders in the aquaculture industry should keep track of international trends and carefully review the applicability of laws and customs in developing countries like Philippines.

4. There may be a need to allocate resources to R&D activities to develop commercially applicable technologies to protect against genetic piracy.

In the absence of laws or the ability to enforce laws to protect intellectual property/breeders' rights, research institutions will have to allocate a portion of their R&D resources and activities to developing commercially applicable technologies to protect breeding programs from genetic piracy. If such research requires considerable scientific and technical work and the potential for coming up with usable or commercially applicable technologies is uncertain, the public sector should consider undertaking such research as part of their strategy to encourage, in the long-run, private sector participation in fish genetic improvement and related R&D.

5. Establish and implement a seed certification program for tilapia.

A seed certification program can serve two functions:

1. The program can provide farmers/growers with some level of assurance that the fry/fingerlings they receive are from a reliable source.
2. The program can provide breeders with some degree of appropriateness due to the barrier to entry that such a program will result in.

A properly designed and implemented seed certification program will thus help encourage private sector investments in research. However, a seed certification program that places unnecessary delays, expenses and other difficulties (i.e., opportunity for graft) on the process of commercializing a breed will serve as a disincentive.

6. Public sector institutions should review the status of the tilapia industry, with emphasis on the seed industry, with the objective of developing a strategy, including policies, to encourage and complement rather than compete with the private sector.

This recommendation was discussed at length in an earlier workshop of the project on "Public-private Sector Partnerships in Tilapia Genetics and Dissemination of Research Outputs" and specific recommendations were made in the "Angeles Declaration" that came out of the workshop (Tilapia Science Center and WorldFish Center 2003).

Pray and Fugile (2001) say that the relationship between private and public research can be "one of either substitutes or complements". Public research will discourage the private sector from investing in R&D if public research institutions develop and disseminate technologies similar to those developed by private companies. They encourage public research to focus on providing important "upstream" science and technology for private firms to adapt into applied product innovations. They also view public research as contributing to the encouragement of private research by expanding the available pool of scientific and technical personnel.

In the area of tilapia genetic improvement R&D and the tilapia seed industry, the following practices by government institutions in areas/regions where a sufficient number of private hatcheries serve the market could be viewed as competition with the private sector.

- selling tilapia fingerlings at prices much lower than those charged by private hatcheries;
- free fingerling dispersal programs; and
- providing breeders to tilapia hatcheries for free or at a minimal cost.

One explanation for the above pricing practices is that government agencies are required to sell produce at no more than the cost of production. Unfortunately, the formulas used for calculating costs of production often do not consider overheads, depreciation costs and other cost factors involved in production. The Angeles Declaration encourages the government agencies involved to be aware of how their distribution and pricing methods impact private sector participation and investments in genetic improvement R&D and dissemination of improved seed (Tilapia Science Center and WorldFish Center 2003).

7. **Review existing policies/laws on: (a) technology transfer by the public sector to the private sector and (b) strategic collaboration on R&D necessary to advance food security and global competitiveness of local agriculture/agri-business.**

Traditionally, most research in tilapia aquaculture has been performed in Philippines by researchers in the public sector. The technology and information resulting from these research activities have been provided to the farming sector for free or almost for free. Although the practice is largely responsible for the growth of the industry to what it is now, it is time to look into these practices that:

- discourage the private sector from investing in R&D; and
- do not allow the government to generate the level of resources that it can from the private sector.

With the decline in international and domestic resources available for public sector agricultural research, R&D by the private sector should be encouraged. Sondahl and Evans (1988) make the following distinctions between the missions of public and private biotechnology research institutions:

- Public institutions, national and international, should be primarily responsible for high-risk technology development, personnel training, supporting data for new legislation, recommending guidelines and monitoring the safety of experiments.
- Private companies have a primary mission to generate and commercialize products, operate within a profit margin that compensates the capital of public investors, and at the same time provide jobs and pay taxes to society.

They make the following point very strongly – "Efforts to make profits at public institutions or to have non-profitable activities in the private sector would distort these missions and most frequently lead to complete failure."

They also make the following recommendations to strengthen collaboration between public and private research institutions:

- Each institution, private or public, should recognize what products it has within the scope of its research: (1) technology (patents, licensing and royalties); (2) seeds; (3) proprietary or potentially proprietary products; (4) new varieties of hybrids; (e) gene constructions, etc.
- All institutions engaged in biotechnology/genetic improvement research should make a fair assessment of the value of each product and thus be in a position to enter into either a commercialization activity or licensing agreement.

- Technology or product developed by the public sector could be immediately commercialized by the private sector under exclusive or nonexclusive licensing agreements, provided that appropriateness (i.e., through patenting, protective technology or seed certification) is secured. Since private companies must guarantee proprietary protection or exclusive agreements to invest in commercialization, it is important to develop a clear policy on this issue to facilitate the relationship between private and public sectors.

- Research groups from both private and public sectors can jointly develop products and technologies and have joint ownership of their discoveries.

There are a number of examples around the world of legislative frameworks that have been put in place to encourage collaboration between public and private sectors as recommended above. In the United States, the Federal Technology Transfer Act and other laws have provided, among others, the following (Tallent 1988):

- made technology transfer a mission of government research institutions and the scientists working in these government research institutions;
- permitted government institutions to license technologies/inventions to private sector research partners;
- permits universities, nonprofits and small businesses to obtain title to inventions developed with government support;
- allowed government research institutions to make advance agreements with large and small businesses on title/intellectual property rights to inventions arising from collaborative research; and
- required that inventors who are government employees share in royalties from patent licenses.

Adopting similar legislation may encourage R&D partnerships between public and private sectors in Philippines and other developing countries.

References

Anon. 2004. Intellectual Property Code of the Philippines (Republic Act No. 8293). [Retrieved January 2004 from http://www.photo.net.ph/ipcode/].

Duvick, D.N. 1988. Research collaboration and technology transfer: the public and private sectors in developing countries and the international seed companies, p. 21-32. *In* Strengthening Collaboration in Biotechnology: International Agricultural Research and the Private Sector. Proceedings of a Conference, 17-21 April 1988, Rosslyn, Virginia.

ICLARM (International Center for Living Aquatic Resources Management). 1998. Dissemination and evaluation of genetically improved tilapia species in Asia. Final Report. ICLARM, Makati City, Philippines.

Pray, C.E. and K. Fugile. 2001. Private investment in agricultural research and international technology transfer in Asia. United States Department of Agriculture. ERS Agric. Econ. Rep. No. 805, 162 p.

Sondahl, M.R. and D.A. Evans. 1988. Use of cell genetics for crop improvement, p. 69-75. *In* Strengthening Collaboration in Biotechnology: International Agricultural Research and the Private Sector. Proceedings of a Conference, 17-21 April 1988, Rosslyn, Virginia.

Tallent, W. 1988. A new era of government-industry cooperation in research and development, p. 423-428. *In* Strengthening Collaboration in Biotechnology: International Agricultural Research and the Private Sector. Proceedings of a Conference, 17-21 April 1988, Rosslyn, Virginia.

Tilapia Science Center and WorldFish Center. 2003. Angeles Declaration: Public-private Partnerships for Dissemination of Research Outputs to End Users. 11 p.

Roles of Public and Private Sectors in Maize Research and Development and Technology Dissemination in Asia

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Abstract

In 1998-1999, this study interviewed 179 public and private seed companies conducting maize breeding research and producing and distributing maize seed in seven Asian countries, namely, China, India, Indonesia, Nepal, Philippines, Thailand and Vietnam. It compared and contrasted public and private sectors in Asia in terms of their: (1) estimated level of investment in maize breeding research; (2) germplasm outputs; and (3) nature and extent of roles played in the maize seed industry.

Since the 1960s, yield gains, rather than area expansion, have fueled increases in maize production in Asia. Yield gains, in turn, have been due to the shift in maize cultivation from mostly open-pollinated varieties (OPVs) to mostly hybrids. This transition also shifted the locus of modern maize breeding research from government research organizations to private national and multinational seed companies. In countries where both public and private sectors participated in maize research, private sector research investment far exceeded public sector allotment for maize research. With more aggressive marketing programs, the private sector captured 89% of the Asian maize seed market in the late 1990s.

National public seed research agencies (including universities and cooperatives) developed and produced more maize OPVs than hybrids, mass-produced and distributed seed cheaply, addressed location-specific production problems and provided agricultural extension services. The private seed companies developed, produced, sold and promoted their own proprietary hybrids. The reluctance of the private sector, however, to address the needs of marginal maize farmers leaves room for the public sector to continue playing an active role in maize research and development (R&D), seed production and modern maize technology dissemination, especially with adequate support from appropriate government policies.

Introduction

In developing economies, maize production ranks first among cereals in Latin America and Africa, but only third in Asia after rice and wheat (FAO 2001). This production comes from about 97 million ha planted to maize (69% of global maize area) in 1997-1999 (CIMMYT 2001). In the same period, around 160 million t of maize grain (27% of world production) was harvested in Asian countries from 43 million ha (31% of global maize area).

IFPRI (2002) projected that global maize demand will increase by 58% from 585 million t in 1997 to 927 million t by 2025, surpassing both wheat and rice demand. In developing countries, particularly in East and Southeast Asia, rising incomes and the consequent growth in meat and poultry consumption have rapidly increased livestock feed maize demand. Unabated population growth and persistent poverty have also kept food maize demand high in poor countries, as in some parts of South Asia.

To serve the growing maize requirement, Asian farmers are gradually shifting to higher-yielding maize varieties and more modern production technologies. In response, maize R&D agencies are aligning their technology generation and dissemination strategies to better serve the changing production and market requirements. The expanding

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opportunities for maize production however challenge Asia's maize seed industries, such that it is important to understand: (1) how the maize R&D system is organized; (2) what roles public and private sectors play in the system; (3) how public and private sectors serve the varying needs of Asian maize farmers; and (4) what technological and policy issues related to maize R&D concern players in the seed industry. This paper would like to share experiences and concerns of Asia's improved maize industry, which may be applicable or relevant to improved tilapia.

Maize Research and Technology Distribution in Asia

In 1998 and 1999, the International Maize and Wheat Improvement Center (CIMMYT) interviewed 179 national public agencies, private seed companies and nongovernment organizations (NGOs) in China, India, Indonesia, Nepal, Philippines, Thailand and Vietnam, which together account for 93% of Asia's maize area. These organizations collectively sold about 167,000 t of maize seed, or 73% of the formal maize seed market in the region in that year.

Maize breeding research

The improved open-pollinated varieties (OPVs) and hybrids that farmers plant are products of an international maize breeding system that includes CIMMYT; hundreds of national, regional, state or district level public breeding programs; and thousands of private national and international seed companies. Maize breeding research ranges from identifying farmers' varietal needs, assembling superior germplasm complexes for use in developing improved varieties, inbred lines and hybrids up to off-station multilocation varietal evaluation and release.

Role of the public sector

When national research systems are initially formed, state-sponsored organizations almost always play a dominant role in developing improved technology and disseminating it to farmers (Morris 1998). Over time, however, the role of the public sector typically declines, and private companies gradually take over their functions. In Asia today, only China and India retain sizeable public agricultural research and extension systems. Excluding these two countries, only 35% of all maize seed organizations in Asia are public, as compared to 71% when they are included. The decline in public maize breeding research has been particularly pronounced in Southeast Asia, where it is today carried out by two or three organizations only per country.

In Asia, most public agencies that are actively involved in maize R&D concentrate on developing and evaluating varieties. Many also move upstream in the germplasm development process, concentrating on genetic resource conservation and prebreeding activities to produce basic germplasm that can be used as source material by commercial breeding programs. A few public agencies produce and distribute maize seed, along with extension services, especially to resource-poor farmers who profit-oriented private companies tend to ignore. (Public agencies also work in favorable areas, although they face more competition from the private sector in these areas.)

Role of the private sector

Global trend shows that after the private sector emerges as a major player in maize breeding research, private companies tend quickly to assume control of commercial maize seed markets (Morris 1998). Private-sector participation in maize R&D in Asia has grown steadily since the early 1990s, when a wave of policy reforms broke up state monopolies on the seed industry. India's huge maize economy alone was being supported by about 230 private national and multinational seed companies, of which 30 had in-house breeding programs (Singh et al. 1995). In contrast, however, Nepal had no private companies with in-house breeding programs, and seed distributors marketed maize seed imported from India.

Private sector research activities in Asia typically depend on company size and volume of seed sold. In general, larger companies establish their own breeding program. Many smaller seed companies, lacking any in-house research capacity, contract with public research programs and even large private companies to multiply and distribute maize seed developed by others. In Asia, about 75-100 companies develop their own proprietary cultivars using conventional breeding methods. A much smaller number – probably less than 15, mostly multinationals – are large enough to venture into biotechnology research.

Seed Production

Both public and private maize seed companies in Asia produce their seed either on their own lands or through contract seed growers/producers. Vietnam's public sector seed companies, for one, maintain their own maize seed production farms, which are mostly used for growing parent seed and limited quantities of commercial maize seed, in close coordination with provincial research stations and agricultural extension offices.

More seed companies however are moving towards contract seed production, which can significantly reduce a company's production and overhead costs. Contract seed production requires contracting farmer groups or cooperatives to produce maize seed. Bioseed Genetics Vietnam, for example, contracts 12-15 cooperatives, or around 2,000 ha of maize area, around Hanoi to produce its hybrid seed. The contracting agency supplies parent materials to contract seed growers, provides technical support, sets an output standard and buys back the seed produced at a premium over the current market price of maize grain. From such seed production contracts, farmers gain regular access to technical expertise during production period, lower production costs because the seed is provided by the seed companies, an assured market for the produce and higher income.

Seed distribution systems[2]

Indirect distribution systems

Individual farmers usually buy fairly small quantities of maize seed; hence seed markets tend to include large numbers of buyers, none of whom accounts for a significant proportion of the overall sales volume. Many seed organizations therefore deliver their products to farmers indirectly through systems of marketing agents or intermediaries who may number from one to several. In the simplest system, maize seed is sold to a retailer who sells it directly to farmers. In more complex systems, maize seed is sold to one or more wholesalers who in turn sell it to retailers who then sell it to farmers. The product gets more expensive when the marketing system gets more complex.

Agricultural input dealers are the most common channels of seed to farmers, but they often carry different brands of seed and may have little incentive to promote any particular brand. As such, some seed companies often assign exclusive seed distribution rights to larger financially stable dealers. In such arrangements, dealers have a vested interest in knowing the product and its management and in conveying this information effectively to farmers.

Direct distribution systems

In direct distribution systems, maize seed is distributed directly from the seed company to the farmers, usually through the company's own extensive marketing network. These systems ensure that the seed is optimally used, enable seed companies to receive valuable feedback about their products, and allow farmers to receive lower seed prices and valuable technical assistance.

Central and state government seed companies in Asia are involved in maize seed production and direct seed distribution. For example, in India, the National Seeds Corporation administered by the central government produces and distributes significant quantities of maize seed, as do some state seed corporations (Pal et al. in Morris 1998). A number of state agricultural departments, research institutes and state agricultural universities also supply small quantities of maize seed directly to farmers, often to promote new releases. A similar public sector seed distribution system exists in Vietnam.

More commonly, however, public R&D agencies no longer participate directly in seed production and distribution, ceding that role to the private sector. For example, the Indonesian Cereals Research Institute sells parent seed of improved maize varieties, for seed multiplication and marketing, to public parastatals and private seed companies. Similar partnerships have also emerged in India and Thailand. In China, however, law prohibits private companies from producing maize seed, so the industry is composed almost entirely of state-owned enterprises.

Public-private sector linkages

Three types of collaborative activities in maize illustrate how public-private sector linkages are growing in Asia: international germplasm exchanges, public-private germplasm transfers and collaborative varietal testing networks.

International germplasm exchanges

Prior to 1960, no formal system existed to provide plant breeders with access to germplasm developed outside their home countries (Traxler and Pingali 1999). Movement of germplasm occurs informally as breeders exchanged promising materials with friends and professional colleagues. The CGIAR system's establishment in the 1960s provided a mechanism for the global breeding community to access research products from public institutions. In Asia, CIMMYT coordinates an international maize germplasm distribution and exchange network, from which promising experimental materials, provided free of charge, may be requested. Once used mainly as a mechanism for distributing materials to public breeding programs, the CIMMYT germplasm distribution network is increasingly being exploited by private seed companies as a source of promising experimental materials.

Public-private germplasm transfers

An increased germplasm transfer from public breeding programs to private seed companies has accompanied the privatization of many national maize seed industries. Reducing investments in seed production and distribution activities, public breeding programs have sought new mechanisms for moving their germplasm products into farmers' fields. In many countries, improved germplasm are made available to seed companies, often on a

[2] Mainly taken from Krull et al. in Morris (1998).

Table 1. Sales of maize seed (t) from public and private sectors, by type of organization, Asia, 1997.

	Maize seed sales (t)		Maize seed sales (%)	
	Asia	Asia excluding China	Asia	Asia excluding China
Public seed agencies	96,150	8,550	57.5	10.7
Private national companies	18,650	18,650	11.2	23.4
Multinational companies	52,450	52,450	31.4	65.9
Total	167,250	79,650	100.0	100.0

Source: CIMMYT Asia maize impact survey, 1998-1999.

commercial basis. For example, Thailand's Kasetsart University can assure multinational and domestic private companies exclusive use of elite inbred lines if these companies are willing to pay royalties.

Collaborative varietal testing networks

Collaborative varietal evaluation trials allow public breeding programs and private seed companies to compare promising experimental materials and exchange information. The Food and Agriculture Organization-funded CIMMYT-managed Tropical Asian Maize Network (TAMNET), composed of public breeding programs and private seed companies from Asian countries, was established in 1993 to facilitate and strengthen regional collaboration among and between member institutions, with the ultimate goal of increasing maize production and productivity (FAO 1999). It manages a multilocational varietal evaluation program; annual field trials are conducted throughout the region, and the resulting data on field performance across countries are synthesized and shared among TAMNET members.

Status and Performance of the Asian Maize Seed Industry

Commercial maize seed sales and market shares

The 179 public and private seed agencies in Asia interviewed for this study reported selling just over 167,000 t of improved maize seed in 1996/1997 (Table 1), of which 5,000 t (3%) was OPV seed and 162,000 t (97%) was hybrid seed. China had by far the largest commercial maize seed market in the region. In 1996/1997, Chinese seed organizations (all of which were public companies) sold 87,600 t of hybrid maize seed, or 52% of all commercial maize seed sold throughout Asia. India and Thailand ranked second and third in commercial maize seed sales, respectively. Nepal had the region's smallest commercial maize seed market; only 1,500 t of commercial maize seed was sold in Nepal, equivalent to slightly less than 1% of the Asian market.

Because all commercial maize seed sold in China is produced by public organizations, and because China's maize seed market is so large, seed sales by public organizations exceed those by private companies for the region as a whole. Including the data for China, 58% of all commercial maize seed sold in Asia during 1996/1997 was produced by public organizations. When China is excluded from the analysis, however, the picture changes dramatically: excluding China, private seed companies dominate the Asian maize seed industry, accounting for 89% of all commercial maize seed sales during 1996/1997.

What explains the increasing domination of private hybrids, especially outside China? Three factors appear to be at work. First, many of the private sector hybrids are simply better than the public sector hybrids. The superior performance of many private-sector hybrids reflects the long-standing concentration of private seed companies on hybrid breeding, as well as more focused targeting of production environments. Second, the quality of private-sector hybrid seed is often better than that of public-sector hybrid seed. Private companies tend to emphasize seed quality assurance, since their economic survival depends on the reputation that they establish among farmers. In contrast, public seed agencies usually have little incentive to look after seed quality. Third, private seed companies on the whole have been much more effective in marketing their hybrids through aggressive advertising and promotion campaigns. They are generally excellent in building production and distribution networks that allow seed to be delivered efficiently to the end-user, often on credit, and sometimes along with complementary inputs such as fertilizer and crop chemicals. In contrast, public seed agencies have tended to distribute their seed through centralized distribution facilities that frequently are inaccessible to farmers.

Composition of maize seed prices

To gain insights about the production cost structure of commercial maize seed, survey respondents were asked to break down the retail price of 1 kg of maize seed into five major components: (1) research and development costs, (2) seed multiplication costs, (3) marketing and distribution costs, (4) overhead and (5) gross margins.

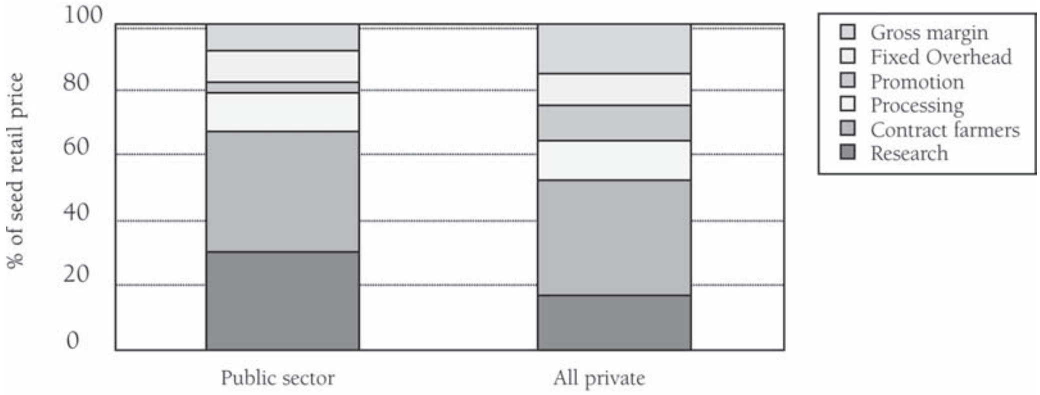

Figure 1. Composition of maize seed prices by type of seed organization, Asia, 1997/1998.

Source: CIMMYT Asia maize impact survey, 1998-1999.

Averaging across the entire sample, public seed agencies reported relatively high R&D costs compared to private seed companies and relatively low seed multiplication costs (Figure 1). Marketing and distribution costs and overhead made up comparable proportions of the seed retail price for both types of organizations. Summing the first four categories and subtracting the total from the retail selling price, private companies earn higher gross margins (15% on average) than public seed agencies (8% on average).

Key Issues

Varietal registration

In many countries, varietal registration is the single most important regulatory issue that affects the maize seed industry. It often involves establishing the seed's genetic identity, and testing its performance. Techniques for establishing varietal identity have become increasingly sophisticated, but almost all are based on morphological characterization. But as intellectual property protection is extended to plant varieties through plant breeders' rights and patent laws, the importance of precise varietal identification and registration (especially with the use of biological and genetic fingerprinting) will increase (Tripp 1998).

If regulations are to guarantee the performance of new maize seed, two or more cycles of testing will be needed to establish consistent performance across different agroclimatic conditions. This translates into an expensive two or three-year delay in the release and commercialization of the material. A growing body of empirical evidence suggests that varietal release procedures often delay the release of promising materials, reduce the overall number of releases and slow the rate of varietal turnover in farmers' fields (Tripp 1998).

Intellectual property rights

The lack of effective plant varietal protection laws in Asia, however, makes the private sector (especially the large multinational seed companies) skeptical about sharing its materials with the public research agencies. Without property protection regulations, the private sector feels that it is difficult to safeguard research outputs. The lack of essential intellectual property laws can discourage many of the private seed companies from introducing their very best materials into the market. In such scenario, the range of better production technologies available to farmers becomes restricted.

Biotechnology

Work on genetically modified maize is already advanced, and commercial applications of biotechnology now include insect and disease resistance, herbicide tolerance, and resistance to some environmental stresses. These however have spawned intense reaction among the general public, to whom biotechnology can be everything from a magic wand to an evil genie (Tripp 1998). In Asia, public reaction to biotechnology products usually veers towards opposition, especially when arguments against it focus on possible risks to human health and safety. This, and the range of special regulatory protocols for the testing, release and utilization of genetic modified materials, ought to be also considered.

Public sector-private sector linkages

How will the relationship between public organizations and private seed companies evolve in the future? A group of experts convened by CIMMYT met in Tlaxcala, Mexico, to discuss the conditions necessary for productive and harmonious collaboration between public and private sectors with respect to R&D for maize and two other leading staple crops, wheat and rice (CIMMYT 1999). This group of experts, which included scientists from public and private sectors, development agency officials, NGO representatives, media specialists and farmers, agreed upon the following points:

- Public organizations can and should continue to play an active role in maize research and seed production; public-sector involvement will help reduce R&D costs for private firms (for example by generating improved germplasm that can be used as inputs into commercial breeding programs and by training researchers).
- Where conditions permit the existence of competitive seed markets, the public sector should complement and support rather than compete with the private sector in providing improved seed and related technology to farmers.
- The public sector has a particularly important role to play in supporting local private seed companies, which can enhance competition in seed markets.
- Where technical, economic or institutional conditions discourage private companies from providing improved seed technology to farmers, public agencies may be called upon to assume responsibility for meeting farmers' needs.
- Even where international research organizations and private seed companies are active, strong national public research programs will often be needed to adapt privately and internationally developed research products to local conditions.

Examples of successful public-private sector collaboration in Asia are especially evident in India and Thailand, where strong public breeding programs have encouraged and supported the development of extremely successful and competitive private seed industries.

The strong likelihood that the private sector will be reluctant to address the needs of farmers in marginal areas should encourage the public sector, including international agricultural research centers like CIMMYT, to continue their active role in maize R&D and seed production, particularly for improved OPVs. Within each country, the public sector should assume a more complementary and supportive role with regard to the private sector by developing policies that facilitate private sector operations. These policies may include the simplification of product test rules or seed certification procedures, and the formulation of intellectual property rights laws, which together will ensure that the best varieties will be available to maize farmers as quickly as possible.

Finally, it is important to recognize that improved maize seed is not the only key to increasing maize productivity and uplifting the conditions of resource-poor maize farmers in Asia. No amount of advanced public or private-sector maize research will help the most disadvantaged farmers unless substantial parallel investments are made in infrastructure, agricultural extension, input production and distribution systems, grain harvest and post-harvest facilities and grain marketing. In the end, the role and impact of appropriate government policies – from those on input and grain prices to those on intellectual property rights – should certainly not be overlooked.

References

CIMMYT (International Maize and Wheat Improvement Center). 2001. CIMMYT world maize facts and trends. Mexico, D.F.

CIMMYT (International Maize and Wheat Improvement Center). 1999. Tlaxcala Statement on Public/private sector alliances in agricultural research. Mexico, D.F.

FAO (Food and Agriculture Organization of the United Nations). 1999. Report of the Third Tropical Asian Maize Network (TAMNET) Meeting, 27-29 October 1998, Hanoi, Vietnam. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.

FAO (Food and Agriculture Organization of the United Nations). 2001. FAOSTAT. Rome, Italy.

IFPRI (International Food Policy Research Institute). 2002. 2025 Projections, International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) special project: Global trends in food supply and demand. Washington, D.C.

Krull, C.F., J.M. Prescott and C.W. Crum. 1998. Seed marketing and distribution, p. 125-142. *In* M.L. Morris (ed.) Maize seed industries in developing countries. Lynne Rienner Publishers and CIMMYT, Colorado, USA.

Morris, M.L., Editor. 1998. Maize seed industries in developing countries. Lynne Rienner Publishers and CIMMYT, Colorado, USA.

Pal, S., R.P. Singh and M.L. Morris. 1998. Country case study on India, p. 251-268. *In* M.L. Morris (ed.) Maize seed industries in developing countries. Lynne Rienner Publishers and CIMMYT, Colorado, USA.

Singh, R.P., S. Pal and M. Morris. 1995. Maize research development and seed production in India: contributions of the public and private sectors. CIMMYT Econ. Work. Pap. 95/03. CIMMYT, Mexico, D.F.

Traxler, G., and P.L. Pingali. 1999. International collaboration in crop improvement research: current status and future prospects. CIMMYT Econ. Work. Pap. 99/11. CIMMYT, Mexico, D.F.

Tripp, R. 1998. Regulatory issues: varietal registration and seed quality control, p. 159-174. *In* M.L. Morris (ed.) Maize seed industries in developing countries. Lynne Rienner Publishers and CIMMYT, Colorado, USA.

Summary of Discussions and Recommendations from the Stakeholders Workshops

The growth and dynamism in the country's tilapia industry and the enhanced prominence of Philippines in the global tilapia science community are largely due to the gains that have been achieved through the successful implementation of collaborative tilapia genetics research programs. The development of new technologies and knowledge and several strains of improved tilapias have led to the establishment of public-private and private sector alliances (e.g., GIFT Foundation International Inc., Phil-Fishgen). These also enabled the breeding programs to be institutionalized and further upgraded the human resources developed during the main public-funded projects.

The availability of several improved tilapia strains in Philippines offers the distinct advantage of providing farmers with strains of their choice and needs. The availability of improved strains has also attracted new entrants to the freshwater aquaculture sector and spawned the growth and development of allied industries and support services. As a consequence, farm productivity has improved, leading to significant contribution of tilapia aquaculture to food security and livelihood enhancement.

Other tangible outcomes that have arisen as a result of these positive developments are the increased awareness among stakeholders of the need for genetic improvement in aquaculture, the conservation of biodiversity, and the recent evolution and establishment of productive partnerships and alliances among the different stakeholders from both public and private sectors (i.e., the Tilapia Science Center and Philippine Tilapia Inc.). Additionally, there are also sufficient reasons to be optimistic about the future with the creation of the Philippine Tilapia Council whereby efforts and resources could be harnessed and pooled together thus enhancing the sustainability of tilapia genetics research and development (R&D) in particular, and the industry in general.

While tremendous benefits have been achieved as a result of development of new technologies and strains of genetically improved tilapias, there are also issues and constraints that emerged and are needed to be addressed through effective partnerships between public and private sectors. The following provides a summary of the discussions and recommendations from the Stakeholders Workshops organized under the Development and Implications of Public-private Partnerships in Fish Genetics and Dissemination of Research Outputs Project.

Public-private Partnerships in Tilapia Genetics Research

Sustainable mechanisms for funding research

Issue

Long-term investigation of traits for selection and facilitating the transfer of benefits of genetic improvement research require substantial amount of capital.

Constraints

- In breeding work, there is a need for sustained funding with long-term objectives. However, at present no such commitment from the public sector exists.
- National partners have limited resources to absorb the staff of donor-funded genetic improvement programs and to sustain the selective breeding work and the maintenance and management of improved stocks.

Recommendations

- The Philippine Government should develop a policy to allocate a certain percentage of R&D budgets to tilapia research, permit a line agency to plow back income from sale of research products into research, and increase efforts for obtaining international and bilateral funding.

Tracking of investments on R&D (tilapia genetics research)

Issue

The absence of financial information and values may contribute to difficulties in negotiating public-private partnerships in R&D as well as in commercialization of R&D outputs.

Constraints

- Research institutions do not have systems for documenting costs or investments made on tilapia R&D. All institutions, with the exception of the GIFT Foundation and GenoMar do not carry on their books, the value of their broodstock.

- Data on level of overall R&D funding (for aquaculture in Philippines) vs. total tilapia genetic improvement research investments are also not clear or available.

Recommendations

- Institutions should make a fair assessment of the value of each research product (historical investments, accounting practices, value to others) for commercialization or licensing.

Policy framework for public-private research collaborations

Issue

A policy framework for encouraging partnerships between public and private sector institutions does not exist.

Constraints

- With the current stage of the tilapia industry in Philippines, there is not much room for private sector to invest in public research.
- Incentives for private sector to engage in collaborative research are inadequate.
- There is lack of mutual trust and risks are associated with competition between public and private sectors.
- There is no policy for public sector to provide breeding material and technology support.

Recommendations

- Policies are needed to encourage private sector investment in research through initiatives such as tax breaks.
- The public sector's competing with the private sector in dissemination of improved breeds should be minimized in order to increase trust and to encourage research collaboration.

Intellectual property rights

Issue

Ownership and commercialization rights of improved strains over succeeding generations of fish

Constraints

- There is no policy that ensures that any kind of protection sought by a party in the future will not restrict the other party in continuing their research or the partners from fully utilizing the products of research.
- Defining intellectual property rights (IPR) and their evolution is difficult where they are not specific (as in copyrights and patents).
- Only trademarks are effectively protectable (component of branding).
- There are conflicting interests between public and private sectors regarding ownership of research outputs.

Recommendations

- Most outputs come from public sector-funded research and hence should be in the public domain; whereas, the private sector is interested in controlling its products to enable recovery of investment.
- Public sector organizations entering into research collaboration with private sector should seek advice on IPR issues.

Maintenance of and accessibility to diverse improved and wild strains for future use

Issue

There is a lack of mechanism for long-term maintenance of improved and wild tilapia germplasm.

Constraints

- To maintain options for future research, it is necessary to maintain gene banks in the long term, which is not the case at present.
- Private sector generally has short-term objectives and thus will not maintain gene banks. Although it is the responsibility of the public sector, long-term resources to maintain gene banks are lacking and the present efforts that exist are ad hoc and uncoordinated.

Recommendations

- Acquire funding support from development assistance community for long-term germplasm maintenance of farmed and wild tilapia strains through establishment of Tilapia Germplasm Trust.
- Management of Tilapia Germplasm Trust needs international support. Besides Philippines, other international nongovernment organizations, such as the WorldFish Center and the World Fisheries Trust, should be involved. The Tilapia Science Center would be a good location and mechanism.
- Philippines, being a signatory to the Convention on Biological Diversity, has to abide by the international code of conduct for transfer of genetic materials. Import-export regulations on tilapia strains should include the Material Transfer Agreement.
- The quality of the improved tilapia strains should be addressed through seed certification.

Oversight of process

Issue

The role of institutions in oversight is not clear.

Constraints

- There is no oversight or notice taken of the approaches used in genetic research, the material to work with or coordination of effort. No process for approval currently exists in the country.
- There are concerns of disease risks related to fish introductions which could seriously damage the industry.
- There are also concerns over environment impacts of genetically improved fish (e.g., saline-tolerant tilapia).

Recommendations

- Biosafety regulations, including appropriate risk assessment, should be given attention in preparing research proposals.
- Related international codes of practice exist and should be taken cognizance.

Public-private Partnerships in Dissemination of Research Outputs to End-Users[a]

Marketing

Issue

Inadequate access of improved strains to poor farmers geographically

Constraints

- There are inequitable distribution and inaccessibility to poor farmers in remote areas.
- There is competition between public and private sectors in dissemination in some areas, while other locations are not served effectively. Distribution and marketing of improved fish seed from most private sector hatcheries (particularly accredited hatchery operators) are mainly concentrated in Luzon. Hence, farmers from geographically isolated regions (e.g., Mindanao) have limited access to improved strains.
- Farmers lack information on different strains available and their properties thus limiting their choice to the strain that is being promoted to them by fingerling producers.
- Private hatcheries and growout operators are not organized.

Recommendations

- The public sector should ensure that small-scale, poor and geographically isolated farmers get access to improved strains. There is a need to balance differential interests of public and private sectors in serving the needs of these farmers and commercialization of the improved tilapia breeds.
- The public sector should ensure availability of information on improved tilapia strains and a policy that will target its distribution efforts in those areas not adequately covered by the private sector. Effective implementation of such policy will minimize competition between public and private sectors. The government should take the lead in collecting, monitoring and disseminating information on markets, prices and other relevant information on fingerlings and table fish. An effective mechanism needs to be established for the collection and dissemination of information to the producers.
- The government should continue to provide extension services and develop innovative delivery systems suitable for small-scale farmers. These mechanisms should be widely communicated to all sectors concerned.
- The government should concentrate on the production and distribution of broodstock, and the private sector, on production and dissemination of fingerlings. The government must continue to distribute fingerlings for growout in areas not served by the private sector.
- Associations/networks of producers should be formed.

Access to technical advice/assistance

Issue

Lack of extension services remains a problem, although the traditional public sector mechanism is effectively working in some geographical areas in Philippines, notably in Luzon. Without extension support mechanisms, it is likely that targeted sector of the industry will be marginalized and left out of the benefits which could be derived from technological change and innovations.

Constraints

- The traditional government delivery system is weak and ineffective.
- Services of local government unit extension workers are not fully tapped because of limitations in expertise and capabilities.
- Alternative delivery systems are not used or tapped.

[a] Note: Where appropriate, the use of information technology products should be considered to take advantage of their benefits.

Recommendations

- Skills should be upgraded and capability of extension workers and farmers should be developed through training programs.
- The participation of the private sector should be enlisted as a conduit for technology transfer.
- New models for delivering technical assistance and services should be developed.
- Breeding nucleus stations (public and private) should be responsible for providing the necessary technical services. Private sector breeding nucleus institutions, in partnership with public sector institutions, should also extend specialized kind of extension services needed by the multipliers and their growout farmers.
- The public sector should continue to provide the traditional type of extension needed by small-scale hatcheries and growout farmers, especially those not reached by existing distribution systems for genetically improved seed.

Protection of biodiversity (wild and agrobiodiversity)

Issue

Weak aquatic biodiversity conservation or protection

Constraints

- Existing laws are weakly implemented.
- There is lack of public awareness on the importance of protecting biodiversity.
- Tilapia is not included or covered by existing Philippine regulations on fish imports and exports.

Recommendations

- There should be responsible transfer in and out of the country. The government should strictly implement existing laws on fish export/import and regulations that concern protection of aquatic biodiversity.
- The government should set up a system to monitor movements of tilapia.
- Practical ecological risk assessment procedures should be developed to determine the impact of improved tilapias.
- Present regulations on importation/exportation of live aquatic products should be modified to include tilapia as a regulated fish.
- The issue of biodiversity should be considered when forging agreement with commercial private sector company.
- Fish should be included in the Philippine biosafety framework. It is necessary that outcomes and recommendations on biodiversity from the present workshop are provided to the Philippine National Biosafety Committee.

Regulation and registration

Issue

Effective ways are needed to ensure that the quality and integrity of genetically improved strains (domestically or internationally bred) and that research investments made for development of these strains are not negated.

Constraint

- There is no established mechanism for regulating the development, production and dissemination of improved tilapias.
- The increasing concern regarding biosafety and the sensitive issue on the management and protection of IPR are not being addressed.

Recommendations

- Government should take the lead in the development of such regulation.
- A consultation meeting should be convened among stakeholders on the subject of fish seed certification system in Philippines, taking into account the lessons learned from other sectors (e.g., crops).
- A study on the feasibility of applicability or workability of seed certification program for tilapia should be carried out.
- A fish seed certification board should be created to serve as an independent screening body. There is a need for a certification system to regulate the development and dissemination of improved tilapia strains.

Quality assurance (HACCP implementation)

Constraint

- Among industry stakeholders, there is lack of awareness of the hazard analysis critical control point (HACCP) regulations.

Recommendations

- Certificates should be issued to multipliers.
- The multipliers should actively participate through training programs, and information, education and communication activities.

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The genetic research programs undertaken by public sector institutions in Philippines have resulted in development of improved strains of tilapia that are now being disseminated to farmers. As institutions move towards further improvement and widespread dissemination of these strains to farmers, the need for establishing partnerships with the private sector is recognized. Public and private partnerships are increasingly being used as a means of addressing global issues in the agriculture sector. However, unlike in crops where implications of such partnerships have been studied and established, in the case of fish, the subject is still new and information on the changes that take place in evolving partnerships is not known.

Public and private partnerships in aquaculture: a case study on tilapia research and development documents the findings of a study undertaken in Philippines during 2002-2004 to enhance the understanding of the evolving public and private partnerships and to determine their effects on sustainability and achievement of developmental objectives in tilapia research. This book discusses the development of collaboration between public and private institutions in tilapia research and development in Philippines, the key players and their roles, and the issues that need to be addressed for enhancing the impacts of partnerships.

TITLES OF RELATED INTEREST

Fish genetics research in member countries and institutions of the International Network on Genetics in Aquaculture. M.V. Gupta and B.O. Acosta, Editors. 2001. ICLARM Conf. Proc. 64, 179 p.

Public-private Partnerships for Dissemination of Research Outputs to End-users. Tilapia Science Center, Philippines and WorldFish Center. 2003. 11 p.

Tilapia genetic resources for aquaculture. R.S.V. Pullin, Editor. 1988. ICLARM Conf. Proc. 16. 108 p.

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