ADOPTION AND FARM-LEVEL IMPACT OF GENETICALLY IMPROVED FARMED TILAPIA (GIFT) IN THE PHILIPPINES

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ABSTRACT

Over the last four decades, the aquaculture sector especially in developing countries has experienced dramatic growth. The increase in aquaculture production is a combination of area expansion and technological change (enhanced strains, input of feed and fertilizer, and improved management). One example of such technological change is the selective breeding efforts on tilapia that were initiated in 1988 by the WorldFish Center (then ICLARM) together with (inter-)national partners. The outcome of the selective breeding effort was a tilapia strain called "GIFT" (genetically improved farmed tilapia) which was first made available in 1993 and which showed significantly higher growth rates in on-farm trials. The strain was first adopted in the Philippines but has since been disseminated in 11 Asian countries. Ex-ante studies had shown the potential of the GIFT strain and concluded that substantial impact from GIFT and GIFT-derived strains can be expected. Our study is an ex-post assessment of the farm-level impact of GIFT and the way the technology has been disseminated and taken up. The study is based on a survey of 780 tilapia producers conducted in 2006/2007 in three different regions in Luzon, the Philippines. We analyze adoption rates of the GIFT strain and compare the performance of GIFT vs. non-GIFT strains and the impact of different factors on tilapia yields. Lastly, we evaluate the profitability of the production of GIFT vs. non-GIFT strains. Our major findings are that based on farmers' reporting the adoption of pure GIFT strains is very low (6%), while almost half of the farmers reported to use GIFT-derived strains. There is uncertainty about the genetic origin of the strains in at least 27% of the cases, and even for the GIFT and GIFT-derived strains questions remain with regard to the purity of the breed. Based on farmers' ratings and the reported production information, the GIFT and GIFT-derived strains did not perform any better compared to other strains. This is likely to be a result of the poor management of improved strains over the last 15 years rather than a shortcoming of the original GIFT technology.

Keywords: Technology adoption, strain performance, profitability, aquaculture, Asia

INTRODUCTION

Over the last four decades, the aquaculture sector especially in developing countries has experienced dramatic growth (FAO 2007). The increase in aquaculture production is a combination of area expansion and technological change. Technological change in aquaculture has largely taken place in the design of hatcheries and grow-out facilities and through increased dependence on formulated feeds or fertilizer, and improved management regimes. Unlike the development of high yielding varieties during the Green Revolution period, the genetic improvement of aquatic species lacks far behind. Until today, there are still relatively few examples of systematic genetic improvement of fish strains (Bilio 2007a, 2007b).

Tilapia (*Oreochromis niloticus*), a freshwater fish originating from Africa, was introduced to several Asian countries in the second half of the last century because of its favorable growth characteristics and ease of cultivation (Welcomme 1988). By the 1980s, tilapia aquaculture had reached high importance for income earning and food security in a number of Asian countries. However, the genetic status of the available strains was poor mainly because of inbreeding and introgression of undesirable genes into the existing brood stocks. Thus a selective breeding effort for tilapia was started in 1988 by the WorldFish Center (then ICLARM) together with (inter-)national partners. The outcome of the selective breeding effort was a tilapia strain called ”GIFT” (genetically improved farmed tilapia) which was available by 1993 and showed significantly higher growth rates in on-farm trials than the original wild and the previously cultured strains (Dey et al. 2000).

The GIFT strain was first tested and adopted by farmers in the Philippines but has since been disseminated in 11 Asian countries. Ex-ante studies had shown the potential of the GIFT strain and concluded that substantial impact from GIFT and GIFT-derived strains can be expected (ADB 2005, Deb and Dey 2004). The yield increase realized by the GIFT strain in on-farm testing in the Philippines was as high as 49% in a pond and 54% in a cage environment (Dey et al. 2000) and by 2003, the adoption rate of GIFT and GIFT-derived tilapia strains had reach a combined share of 77% at the hatchery level for the entire Philippines (ADB 2005, Appendix 2).

OBJECTIVES OF THE STUDY

The objective of this study is an ex-post assessment of the farm-level impact of GIFT. Since in the past the rate of adoption has only been assessed at the hatchery-level, this will provide the missing link to determine ultimate development impact of this technology. In particular we are interested in the adoption rate of GIFT and GIFT-derived strains by (small-scale) aquaculture producers in Luzon, The Philippines, and the farm-level performance of these GIFT and GIFT-derived strains as compared to other tilapia strains used by farmers.

HISTORY OF GENETIC IMPROVEMENT OF TILAPIA IN THE PHILIPPINES

The first tilapia introduced to the Philippines was the Mozambique tilapia *(Oreochromis mossambicus)* imported from Thailand in 1949. Mozambique tilapia was not popular due to its prolific breeding which leads to overpopulation in culture systems and consequent stunted growth. The fish can tolerate high salinity and became a feral species in both fresh and brackish water ponds. In addition, its dark color and small size were not appealing to consumers.

In 1972, Nile tilapia *(O. niloticus)* was first introduced to the Philippines and rapidly gained popularity with farmers and consumers, reviving the interest in tilapia culture (Guerrero III 1985). However, inbreeding and accidental hybridization between the two species produced low quality of tilapia brood stock. Together with industrial expansion, problems of low yield and decreased performance of tilapia were reported due to genetic deterioration (Sevilleja 2005). This marked the starting point of various national and multi-national efforts for genetic improvement of tilapia. The focus was on improving yield, primarily through selection for faster growth. In addition, strains were monitored for high survival rate.

As a response, the first tilapia breeding program, a collaboration between the Freshwater Aquaculture Center at the Central Luzon State University (FAC-CLSU) and the International Development Research Centre (IDRC) and the University of Dalhousie in Canada, started in 1986. In 1987, the International Center for Living Aquatic Resources Management (ICLARM, now The WorldFish Center) organized a workshop on ‘Tilapia Genetic Resources for Aquaculture’ during the 2nd International Symposium on Tilapia in Aquaculture held in Bangkok, Thailand. The workshop concluded that the genetic quality of available Nile tilapia in Asia was poor, which led to the multinational arrangement of the ‘Genetic Improvement of Farmed Tilapias’ (GIFT) project in 1988. The project primarily focused on improving the status of Asian and African tilapia stocks, especially the Nile tilapia species, and establishing and strengthening national fish breeding programs. The collaboration was funded by the Asian Development Bank and United Nations Development Program.

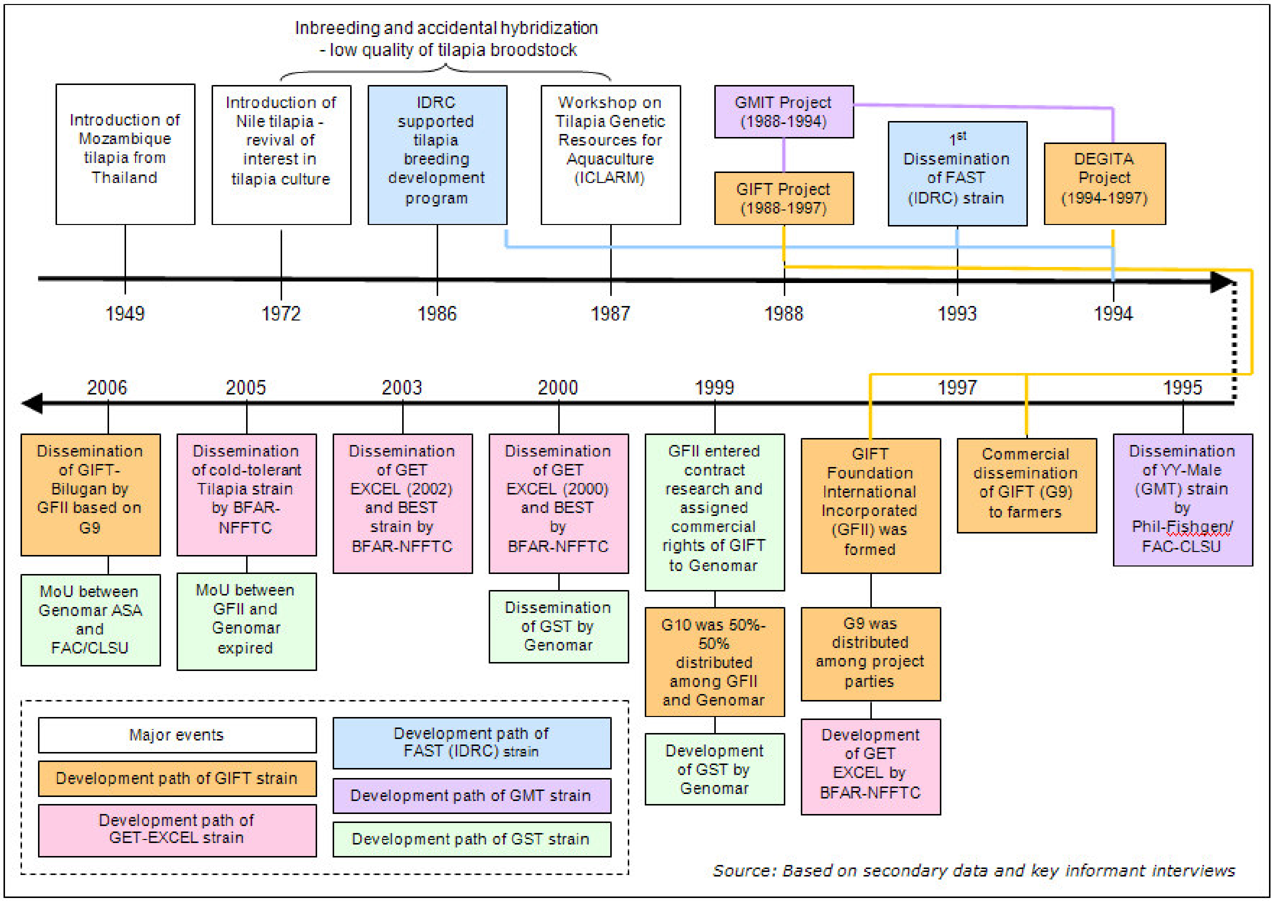


Figure 1: Timeline of tilapia breeding and dissemination of improved strains in the Philippines

In the same year, the Genetic Manipulation for Improved Tilapia (GMIT) was initialized by the University of Wales, Swansea, in partnership with CLSU. During 1994-1997, the Dissemination and Evaluation of Genetically Improved Tilapia Species in Asia (DEGITA) Project was implemented to assess the potential of GIFT adoption prior to the commercial distribution. When the GIFT project ended in 1997, the GIFT Foundation International Incorporated (GFII) was established and the GIFT brood stock was distributed among project partners. The Bureau of Freshwater and Aquatic Resources – National Freshwater Fisheries Technology Center (BFAR-NFFTC) have since continued the development of the strain using the original GIFT brood stock.

The resultant GET-EXCEL strain (Genetically Enhanced Tilapia-EXcellent strain that has Competitive advantage with other tilapia strains for Entrepreneurial Livelihood) has been promoted and widely disseminated by BFAR since 2000. At the same time, GFII went on to set up a contract with Genomar ASA, a private company based in Norway. The brood stock of G10[1] was equally distributed between the two parties and Genomar received the commercial rights to use the GIFT brand name, GFII providing research and development (R&D) cooperation in exchange for the equity. The contract expired at the end of 2005 and GFII has since resumed breeding and dissemination of GIFT (using G9 and marketing under the name of 'GIFT Bilugan'). Figure 1 gives an overview and shows the timeline of major events and efforts in tilapia breeding in the Philippines.

Today, tilapia is the second most important farmed fish in the Philippines after milkfish and tilapia production has increased from 8.8% of the total volume of aquaculture production in 2001 to 9.4% in 2003, whereas the share of milkfish decreased from 18.5% in 2001 to 17.0% in 2003[2].

Table 1: Tilapia production in the Philippines from 1995 to 2005 (by province)

Region	Production (million tonnes)					
	1995	1997	1999	2001	2003	2005
Philippines total	**81,954**	**91,834**	**83,832**	**106,746**	**135,995**	**163,003**
Pampanga	22,483	25,081	27,595	32,654	46,179	54,244
Batangas	13,581	21,541	21,785	22,918	28,566	36,039
Laguna	3,327	3,129	3,265	6,206	7,787	9,196
Bulacan	4,350	2,814	2,600	10,040	8,503	7,236
Rizal	5,327	4,882	4,701	2,069	4,263	6,893
Sultan Kudarat	233	219	893	2,018	6,935	6,836
Camarines Sur	10,266	12,383	3,336	3,508	4,694	6,139
Nueva Ecija	7,367	7,657	3,991	5,206	5,339	5,244
Pangasinan	1,375	1,380	1,054	1,918	2,451	3,636
Isabela	608	1,067	1,133	2,225	2,234	3,556
Others	13,037	11,681	13,479	17,984	19,043	23,985

Source: Bureau of Fisheries and Aquatic Resources (BFAR)

Tilapia production in the Philippines has increased continuously during the past decade and the total production amounted to 163,003 million tonnes in 2005 - an increase of almost 100% since 1995. As of 2005, Pampanga province has the highest production of tilapia, followed by Batangas, Laguna and Bulacan. The aggregated production of these four provinces accounts for 60% of the total national production (Table 1). The rapid increase in tilapia production has resulted in subsequent price changes. Although the nominal price of tilapia has been steadily increasing, the average real prices of tilapia have been decreasing over the last decade. In addition, prices fluctuate considerably over the year (evident from monthly price data provided by the national Bureau of Fisheries and Aquatic Resources).

SAMPLING AND DATA COLLECTION

We used a multi-step procedure to identify the study areas for this survey. Based on the national tilapia production statistics (Table 1) the top three producing provinces were selected as survey sites. In addition, we included Nueva Ecija in the sample because of the proximity to the major tilapia breeding center in Muñoz – assuming farmers there would have easy access to the different improved strains. Finally, we opted to include three provinces in Region II (namely Isabela, Nueva Vizcaya, and Quirino) with poorer infrastructure and only recent uptake of tilapia farming.

In Region IV (Southern Luzon) tilapia cage culture is prominent due to the large area of inland water bodies. Cages are often operated by a care-taker who receives either capital or inputs directly from the investor. This set-up is more frequent and production more commercial in the Batangas area (Lake Taal), while operations are mainly family-based in the Seven Lakes area in Laguna province (Tongruksawattana 2007). The dominant production system in Region III (Central Luzon) is pond production and tilapia has gained popularity during the last two decades, especially since the eruption of Mt. Pinatubo in 1991 when the land became unsuitable for rice production. Today, the region is the major producer of tilapia with a very large number of hatcheries and good infrastructure for aquaculture. Tilapia production grew rapidly since 2003 in Region II (Cagayan Valley), but one constraint is the low infrastructure level and the availability of seed.

Table 2: Sample size for the farm-level survey of tilapia producers in the Philippines

	Sample size [N]							
	Region II			Region III		Region VI		**All**
Type	Isabella	Nueva Viscaja	Quirino	Nueva Ecija	Pampanga	Laguna	Batangas	
Pond	40	60	59	120	120	**-**	**-**	**399**
Cage	80	-	1	-	-	150	150	**381**
Total	**120**	**60**	**60**	**120**	**120**	**150**	**150**	**780**

For all selected locations, lists of tilapia grow-out operators were obtained from the respective Provincial and Municipal Agriculture Offices and the Bureau of Agricultural Statistics. The municipalities to be included in the survey in each province were selected based on the production level and the number of tilapia grow-out operators. Within those municipalities the individual operators were selected randomly. The sampling procedure was thus a stratified random sampling. The distribution of the sampled farmers by region and province is shown in Table 2. In total, 780 individual tilapia producers – about half operating ponds and the other half cultivating tilapia in cages (the two major production environments in the Philippines) – were interviewed face to face using a structured questionnaire. The interviews were conducted between October and November 2006 in Region IV and in February and March 2007 in Region II and III. The questionnaire for the survey was developed after an inception visit to the field in August 2006 and subsequently adapted after several rounds of pre-testing conducted as part of the enumerator training. The information collected during the interviews comprises general farm and farmer demographics (family size, educational level, land holdings, income and income sources), production inputs and details on the 2006 tilapia grow-out cycle, the tilapia strains adopted since 1997 in Region IV and 2000 in Region II and III, strain performance evaluation as well as future plans.

During the survey in Region IV it became evident that almost all producers (94%) gave a "common" strain name (such as "Tagalog" or "Nilotica") which did not allow conclusions on the genetic background (Tongruksawattana 2007). Since the major purpose of the survey, however, was to determine the adoption level of GIFT and GIFT-derived strains as well as compare the performance of these with non-GIFT (either traditional or improved) strains, a hatchery follow-up survey was initiated in order to identify the genetic origin of the strains. Based on information from the farmer interviews we listed the source of seed for all those farmers who gave inconclusive strain names and came up with a list of 103 hatcheries and nurseries in Laguna and Batangas Provinces. During the hatchery follow-up survey during February and March 2008, we then traced those hatcheries and were able to interview 71 of them (others could either not be traced or were duplicates). Hatchery operators were asked about the tilapia strains which they sold in 2006 and 2007, the source and strain of the breeders used, the performance of different strains at the hatchery level, and the major criteria for customers to purchase different tilapia strains. The information provided by the hatchery stated as seed source by the farmer was used to "update" the strain information in the producer survey. This way, the share of "unidentified" strains could be reduced to 71% in the Region IV sample. In the other two survey regions, there was no problem with unspecified strains.

RESULTS

Data cleaning was conducted first by checking the questionnaires on the spot and confirming missing or conflicting information with the enumerator. In some cases this meant returning to the farmer. Nevertheless, when plotting the data on input use and yield, there were some obvious extreme values that did not match the overall distribution of the respective variables. Thus, in a data cleaning step, values that were higher or lower than the group mean by a factor of >1.5 times the standard deviation were considered errors (either in reporting or recording) and thus excluded from the analysis.

Table 3: Farm and farmer characteristics of tilapia producers in the sample (by region)

	Region II (N = 240)	Region III (N = 240)	Region VI (N = 300)	All (N = 780)
Household head age [years]	43 (12)	45 (13)	43 (12)	44 (12)
Highest educational level of household head				
No formal education [%]	0	0.8	1.3	0.7
Elementary school [%]	30	38.3	31.7	33.2
High school [%]	42.1	35.4	50.3	43.2
Others [%]	26.3	25.0	16.7	21.9
Tenure status of pond/cage facility				
Owner operator [%]	93.3	70.0	56.4	71.9
Care taker [%]	5.4	27.5	40.3	25.6
Others [%]	1.3	2.5	3.3	2.5
Average farm size				
Pond [ha]	0.38 (0.82)	2.31 (3.43)	-	1.54 (2.87)
Cage [ha]	0.08 (0.12)	-	0.31 (0.02)	0.26(0.37)
Yield				
Pond [t/ha]	10.13 (13.92)	5.24 (3.03)	-	7.18 (4.96)
Cage [t/ha]	97.35 (86.03)	-	119.92 (173.66)	115.12 (159.29)

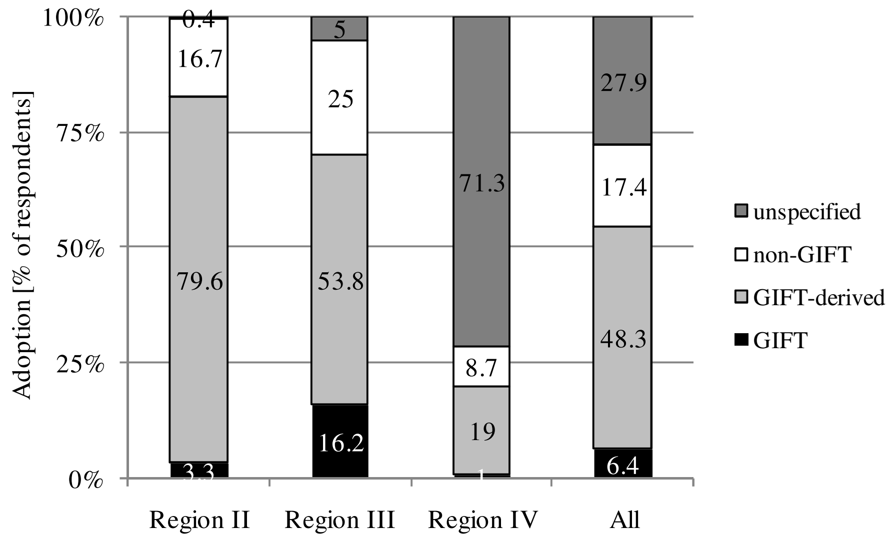
Note: Figures in parentheses are standard deviations.

Data were first analyzed using MS EXCEL 2007 and STATISTICA 6.0 to generate basic descriptive statistics of the most relevant variables. Table 3 shows some general characteristics of the producers included in the sample. While there is very little difference between the age and educational level of producers across the regions, the ownership arrangements are very different for the three locations (Table 3). In Region IV some 40% of the respondents were care takers operating the cages on behalf of financiers; such arrangements were less common in Region III. Under caretaker arrangements, net profits are shared between both parties on agreed terms; caretakers absorb some of the operating risks because they receive no wages. In Region II, the large majority of producers (93%) are owner operators (Table 3). The large difference in farm size across regions can partly be attributed to the production environment i.e. cage operations in Region IV occupy much smaller areas in a few major natural lakes with strict area regulations than the ponds in Region III. Farm sizes are much smaller in Region II regardless of production system, however. Yields are different for pond and cage farming. This is partly because cages have a depths of some 5 meters as compared to the average 1.5 meters for ponds but also because the intensity of production in terms of external input use (mainly feed, see Table 6) is higher and cage farming relies on environmental services such as removal of potentially toxic waste metabolites and replenishing of dissolved oxygen provided by the through-flow of water.

Adoption of GIFT

One objective of the study was to assess the adoption of GIFT and GIFT-derived strains at the farm-level. During the survey we found that farmers were cultivating a large number of different tilapia strains. In order not to blur the picture with too many details, we grouped all strains into the four general categories:

i) GIFT;
ii) GIFT-derived, i.e. developed using GIFT in the breeding process;
iii) non-GIFT (either other improved or traditional breeds); and
iv) unspecified (all strains that could not be allocated to any of the above categories with certainty).



Note: **GIFT** (includes the following strains: GIFT, Genomar Supreme Tilapia, GIFT Bilugan); **GIFT-derived** (comprises: GET-EXCEL, any crossbreeds of GIFT or GIFT-derived with others), **non-GIFT** (FAST, Israel, Mosambique, Singapore, Egyptian, Thailand, Taiwan and crossbreeds among non-GIFT), **unspecified** (Nilotica, Tagalog, Danao, Sex reversed, GMT/YY-Male, Regular, Pla-pla, Ordinary, any crossbreeds of unspecified strains).

Figure 2: Adoption of different tilapia strains in the survey sample (2006 season, by region)

Figure 2 shows the findings of our 2006 producer-level survey. First of all, there are striking differences among the different regions. In Region II, while pure GIFT strains are rare, a large share of operators (almost 80%) used GIFT-derived strains. In Region III, the share of pure GIFT strains was highest (16%), while at the same time some 30% of farmers used non-GIFT strains. In Region IV, the majority of operators cultivate species of unknown origin and due to the large number of small hatcheries in the area and the fact that middlemen are frequently involved in the marketing of seed, we could not allocate the strains with certainty to any of the above categories even after the follow-up hatchery survey. Overall, more than half of the grow-out operators interviewed were using GIFT or GIFT-derived strains. At the same time, pure GIFT strains are not common. One reason for this situation may be that farmers in Region IV reported that they liked the GIFT strain when they first tried it, but that in subsequent years, the quality was much poorer. This could have happened because of intentional mixing or mislabeling of seed by middlemen, or because of poor brook stock management of small hatcheries. The experience of poor GIFT performance could have resulted in farmers adopting other tilapia strains.

Table 4: Adoption of GIFT and GIFT-derived tilapia strains from 1997 – 2006 (by region)

	1997	2000	2002	2003	2004	2005	2006
Region II		*N = 140*	*N = 176*		*N = 220*		*N = 240*
GIFT [%]		8	10		11		3
GIFT-derived [%]		86	85		85		80
Region III		*N = 95*	*N = 143*		*N = 188*		*N = 240*
GIFT [%]		13	29		28		16
GIFT-derived [%]		46	59		60		54
Region IV	*N = 297*	*N = 298*		*N = 297*		*N = 297*	*N = 300*
GIFT [%]	13	12		5		2	1
GIFT-derived [%]	< 1	< 1		< 1		2	19

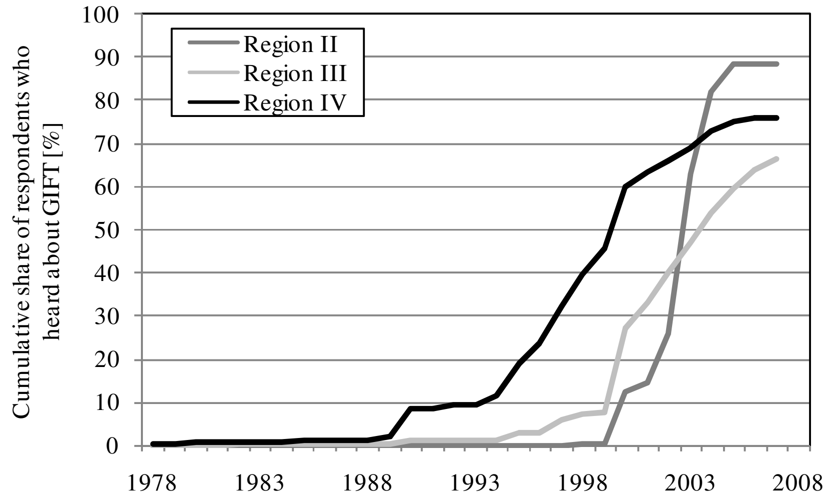


Figure 3: Cumulative share of respondents who had heard about GIFT [%] (by region)

To investigate the life cycle of adoption of GIFT, we asked for the adoption history of different strains. Although the figures are only for a limited number of years and do not extend very far back into the past, it seems that the adoption rate of pure GIFT peaked around 2002 with slight differences among the regions (Table 4). This is consistent with the fact that Genomar is no longer actively disseminating seed in the Philippines and the GIFT Foundation (GFII) only re-started small-scale operations in early 2006. In addition to the actual adoption of GIFT, we asked how many of the farmers knew about the strain and when they first learned about it. Figure 3 shows that most respondents know the GIFT strain. But for the different locations, knowledge spread at different rates, with famers in Region II only learning about it recently, in line with the short history of tilapia production in this area.

As a next step, we tried to explain the adoption behavior of farmers using a Logit model. This analysis was intended to reveal the factors affecting the adoption of GIFT. We estimated regression models based on the survey data separately for the pond and cage environment. The models consisted of explanatory variables covering tenure status of pond/cage facility (own or care taker), geographical aspect (location) farming inputs (size of pond or cage area, source of fingerlings), source of information regarding GIFT, access to extension services, farmers' personal characteristics (gender, age, education) and strain performance perceived by farmers (see next section for details). The dependent variable was a dummy for GIFT adoption (1 if farmers were using GIFT or GIFT-derived strains and 0 otherwise). However, none of the models showed results with a satisfactory level of significance to explain the adoption of GIFT and findings are thus not reported here. We conclude that the explanatory variables do not determine strain adoption to a significant degree. Based on the results of the analysis of strain performance, productivity and profitability, it seems that there is in fact little difference among the strains, or at least what are perceived by farmers to be identifiable strains (see next sections). Thus other factors such as the proximity to certain hatcheries, i.e. access to specific seed and the relationship between hatchery operator and producer or the price of seed seem to be factors driving adoption. Also, the fact that farmers don't seem to be concerned about which strain they are actually using (especially in Region IV, as evident from the large share of unidentified strains) confirms the notion that the strain used is not a major determinant of the productivity and profitability of the enterprise. This is supported by the result that the majority of grow-out operators are satisfied with their source of seed (with satisfaction levels slightly higher for government hatcheries as compared to private hatcheries). There was no difference in the level of satisfaction of respondents using GIFT or GIFT-derived and those using non-GIFT seed.

Table 5: Farmers' rating of performance of strains according to major characteristics (by region)

	Region II				Region IV			
	GIFT	GIFT-derived	Non GIFT	Un-identified	GIFT	GIFT-derived	Non GIFT	Un-identified
Cage								
Sample size N	none	74	2	1	3	44	20	200
Taste		1.98	2.00	2.00	1.67	1.64	1.55	1.61
Body shape		1.98	2.00	2.00	2	1.86	1.75	1.95
Color		2.00	2.00	2.00	1.67	1.8	1.55	1.95
Growth rate		2.48	2.00	2.00	2.67	2.48	2.10	2.40
Survival		2.94	2.00	2.00	2	2.32	1.85	2.07
Seed price		2.02	2.50	2.00	2.33	2.34	1.85	1.96
Seed supply		2.01	2.00	2.00	2	1.84	1.60	1.76
Market demand		2.01	2.00	2.00	2.33	1.75	1.70	1.83

	Region II				Region III			
	GIFT	GIFT-derived	Non GIFT	Un-identified	GIFT	GIFT-derived	Non GIFT	Un-identified
Pond								
Sample size N	7	113	36	none	33	122	49	11
Taste	2	2.04	2.00		2.67	2.47	2.41	2.18
Body shape	2	2.08	2.00		2.73	2.47	2.43	2.09
Color	2	2.05	2.00		2.64	2.53	2.45	2.18
Growth rate	2.43	2.38	2.19		2.7	2.88	2.33	2.09
Survival	3.43	2.67	2.27		3	2.84	2.45	2.09
Seed price	2.14	2.12	2.13		3.06	2.53	2.69	2.36
Seed supply	2	2.04	2.02		2.67	2.42	2.51	2.00
Market demand	2	2.05	1.91		2.79	2.43	2.59	2.18

Strain performance

Tilapia producers were asked to rate the performance of different tilapia strains which they had used for major criteria such as the taste, body shape, color, growth rate, survival, seed price, seed supply and the market demand. They were given the option to score on a scale from one to five – with one being the best rating (equivalent to very good performance) and five being the poorest rating (meaning very poor performance). Table 5 shows the result grouped by strain category and region. There are two general observation for the comparison of strain performance: a) the non-GIFT strains received a more favorable rating in general, and b) the difference between the ratings for the strain groups is very small for most performance characteristics, indicating that strain performance is almost the same and thus the decision of which strain to adopt possibly of less importance to the farmers.

Table 6: Productivity of and input use for tilapia production (by strain group and region)

	Region II		Region IV		
	GIFT and GIFT-derived	Non GIFT	GIFT and GIFT-derived	Non GIFT	Unidentified
Cage					
Sample size N	*77*	*3*	*60*	*26*	*214*
Yield [t/ha]	88.6	79.16	27	30.8	64.6
	(27.2)	(35.60)	(39.6)	(49.5)	(86.7)
Feed [t/ha]	97.6	38.19	243.6	318.8	773.8
	(81)	(30.02)	(258.2)	(457.2)	(1121)
Seed [pieces/ha]	14,644,365	3,080,509	480,597	533,474	484,832
	(8,527,656)	(2958717)	(740,803)	(755,603)	(481,072)
	Region II		**Region III**		
	GIFT and GIFT-derived	**Non GIFT**	**GIFT and GIFT-derived**	**Non GIFT**	**Un-identified**
Pond					
Sample size N	*122*	*37*	*168*	*60*	*12*
Yield [t/ha]	9.4	12.4	5.1	5.27	6.71
	(11.7)	(19.6)	(3.3)	(1.95)	(2.8)
Feed [t/ha]	8.7	9.1	6	6.38	3.98
	(8.1)	(5.4)	(4.1)	(1.85)	(2.61)
Fertilizer [t/ha]	23.5	24.3	5.2	0.27	5.87
	(34.5)	(28.4)	(25.9)	(0.36)	(10.1)
Seed [pieces/ha]	450,328	546,260	550,979	18,859	428,382
	(469481)	(434,868)	(1,531,002)	(11,547)	(724,194)

Note: Figures in parentheses are standard deviations

Table 7: Profitability of tilapia production by production system and strain type (by Region)

	Region II		Region III		
	GIFT and GIFT-derived	Non-GIFT	GIFT and GIFT-derived	Non-GIFT	Un-identified
Yield [t/ha]					
Pond	9.4 (11.7)	12.4 (19.6)	5.1 (3.3)	5.4 (2.1)	6.7 (2.8)
Cage	88.6 (27.2)	82.3 (29.7)	-	-	-
Input costs [USD/cycle/ha]					
Pond	5,385 (6,200)	9,264 (12,788)	3,378 (2,089)	4,033 (1,891)	2,843 (1,347)
Cage	64,465 (26,782)	62,584 (36,492)	-	-	-
Profit [USD/cycle/ha]					-
Pond	8,358 (15,303)	9,242 (20,302)	2,666 (3,953)	2,294 (2,289)	5,035 (3,792)
Cage	61,268 (26,823)	51,827 (41,995)	-	-	-

Note: conversion rate 1 USD = 44.385 Peso (22 July 2008)

Productivity and profitability

As a next step, we analyzed the input use and productivity of tilapia production by strain category and for each of the regions and production environments. Table 6 summarizes the results. There is no general difference in the input structure and yield of GIFT and non-GIFT samples, and yields are not systematically higher for either the GIFT or non-GIFT samples. The considerable difference in the level of inputs and the yields across regions can partly be explained by the size of the operation (i.e. very small intensively operated ponds in Region II), and partly by environmental factors such as the higher pollution level of water bodies in Region IV as compared to Region II. However, these findings require further investigation for example via the estimation of a production function to elicit the most influential factors.

To analyze the productivity and profitability of different tilapia strains, data from Region II and III of the producer survey were used. Region IV is not included in the analysis due to lack of data. Overall, the results indicate that GIFT and non-GIFT farming show little, if any, differences in the productivity and profitability of tilapia grow-out farming in both regions (Table 7). In Region II, GIFT and GIFT-derived performed better for the cage production system; however, based on the data used there is no systematic pattern on the effect of GIFT and non-GIFT on profitability for pond culture. GIFT generates more profits in Region III than non-GIFT strains and vice-versa in Region II. The major driving factor seems to be the type and level of inputs used rather than the strain of seed stocked.

CONCLUSIONS

Based on the preliminary analysis of the farm-level data collected in the 2006/2007 survey in three different regions of Luzon to assess the impact of the GIFT strain, we find that the pure GIFT strain is currently not widely adopted in the major tilapia producing areas in the Philippines. However, it has been adopted and extensively used by the national breeding system (e.g. in the development of strains such as GET-EXCEL) and the majority of strains farmers in our sample are cultivating were of GIFT or GIFT-derived origin. We have to caution, however, that this analysis depends on the information received by farmers and thus the strain information might not be correct or each of the strains may include a range of different qualities. Problems such as introgression of unwanted genetic material and inbreeding due to poor management of the brood stock may have resulted in a considerable compromise of the quality of improved strains thus resulting in lower performance as compared to the findings at the time the strains were first released. To assess the genetic potential of the different strains currently cultivated in the field, however, would require DNA testing and experimental trials.

A low adoption rate of GIFT seems plausible, first because fish strains, as much as crop varieties, may follow a typical life cycle and are eventually replaced by newer (superior) varieties or strains. The GIFT strain was first released in the early 1990s, almost 15 years ago. At the same time, there is indication that GIFT seed might not even have been (easily) available to farmers or might have deteriorated in quality, leading to farmers either choosing other (cheaper) varieties. Since there is little difference in the performance, productivity and profitability of strains (and none of the traditional factors in adoption models such as the farm size, education, and age of the farmer turned out significant), we conclude that other factors such as the proximity to hatcheries and existing contacts with reputable hatcheries or middlemen are a major determinant of the strain selection decision.

The fact that farmers and in many cases even hatchery operators were not sure about the actual genetic origin of the fish cultivated, stresses the importance that countries wishing to use improved fish strains have the capacity to continue to develop and manage it as part of a national breeding program, and to multiply and effectively disseminate the seed to those who need it.

At the same time, there are certainly lessons to be learnt in how to best ensure the sustained quality of improved strains and assist recipient countries in maintaining and disseminating high quality seed. One factor determining the survey findings was without doubt the way the Private-Public Partnerships was set up which resulted in the fact that GIFT seed was and is simply not available in many locations.

Nonetheless, one objective of the GIFT project was to increase the national breeding capacity of the countries involved by conducting trainings and our findings –high adoption rates of GIFT-derived strains – indicate that this goal has been achieved. The fact that the performance of the different tilapia strains was very similar could either mean, that by now all available seed has a higher standard (because of crossbreeding with GIFT and other improved varieties and capacity building within the national breeding sector) and thus the situation has improved considerably for the farmers. It could also mean that the quality of the improved strains has been deteriorated so much, that they don't perform better in the field any more despite the high potential that has been demonstrated in on-farm trials at the end of the breeding effort. If there really has been an increase in the overall yield level, further analysis will be required, to separate the impact of a breeding success from other technological change (e.g. increase in technical knowledge of operators, availability of medication, other improved farm management, use of formulated feed and fertilizers).

Our findings also show how important the timing of data collection for impact surveys is. If conducted too early, results will be largely overestimated, while if conducted too late, farm-level benefits (e.g. in terms of adoption) might have decreased or disappeared, leading to underestimation of the overall impact.

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ENDNOTES

[1] The number indicates the generation of GIFT strain developed, e.g. G10 refers to GIFT strain generation 10.

[2] Fisheries Statistics of the Philippines 2001-2003. Bureau of Agricultural Statistics.

[3] Cage culture is the rearing of fish in enclosures made of (synthetic) nets in water bodies such as lakes or rivers.