Genetic Manipulations for Improved Tilapia (GMIT) Technology Adaptation and Development I

Funded by the ODA Fish Genetics Programme (R 5068A)

Final Report

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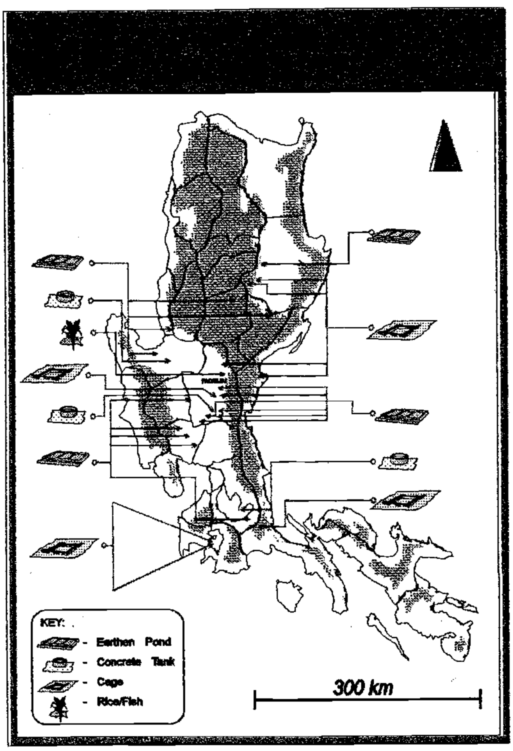

Field Testing and Transfer to Thailand of the YY Male Technology for the Mass Production of Monosex Male Tilapia

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Executive Summary

This work has been conducted as a collaborative research project funded solely by a grant (R.5068A) from the British Overseas Development Administration (ODA) through the Fish Genetics Component of its Renewable Natural Resources (RNR), Aquatic Production Systems Research Programme.

The project has been executed by the School of Biological Sciences of the University of Wales Swansea (UWS), in principal collaboration with the Freshwater Aquaculture Center of Central Luzon State University (FAC\CLSU) in the Philippines and with the Asian Institute of Technology (AIT) and the National Aquaculture Genetics Research Institute (NAGRI) of the Department of Fisheries (DOF) in Thailand.

The Nile tilapia *Oreochromis niloticus* (L.) is cultured extensively worldwide, particularly in Southeast Asia, where it commonly represents a vital basic protein resource for rural communities. Following rapid expansion of the culture of tilapia in the region since 1970, production stagnated in the 1980s before entering a further period of expansion in the 1990s, driven by expanding local and export markets.

The major problems facing the development of tilapia culture throughout the world, but particularly in Southeast Asia where the greatest volume of tilapia is produced, is the shortage of seed, the poor genetic quality of available fry and the problem of precocious sexual maturation and unwanted reproduction during culture. The problem of unwanted reproduction in fish ponds is a major limitation to the realisation of optimal yields in the culture of tilapia due to the diversion of energy from somatic growth into reproduction, and the competition for available food and space resources between parent stock and their recruits. This phenomena commonly results in harvested biomass consisting of large proportions of unmarketable recruits and a consequent failure to maximise revenues.

Several solutions to this problem have been proposed including manual sexing, controlled predation, hybridisation and hormonal sex reversal. It is considered that the culture of monosex male populations is the most effective solution to the problem of unwanted reproduction. Despite many years of research, no reliable technology for the production of monosex tilapia has been developed for effective application in developing countries.

Following on from previous laboratory based research into several aspects of tilapia genetics, two ODA funded research projects (R.4452 and R.4803), running sequentially from April 1988 to March 1994, made considerable progress in the development of a genetic technology for the production of all-male tilapia in the commonly commercially cultured *Oreochromis niloticus*. This technology, known as the "YY male technology", enables the production of novel YY male genotypes which father only male (XY) progeny in crosses with normal (XX) females.

These previous projects demonstrated that YY Males have viability and fertility equivalent to normal. These YY males have produced genetically male progeny ("GMT") with phenotypic sex ratios ranging from 67 to 100% male with a mean of approximately 96%.

Toward the end of R.4803, YY males were successfully sex reversed to female through further optimization of feminization techniques, making possible the large scale production of YY males from YY x YY matings. Also under R.4803, on-station growth trials of GMT populations demonstrated very significant increases in yield over both sex reversed male (SRT) and mixed-sex populations (MST) in within and between strain comparisons. In addition, GMT was demonstrated to have better survival, food conversion ratios and uniformity of harvest size. Also females in GMT populations appeared to be late maturing and therefore pose little problem in relation to recruitment in cultured populations.

This project summarised in this report had two principal objectives:

- *To test the feasibility of large scale production of genetically male tilapia (GMT) and determine their potential impact for Philippine tilapia farmers through the conduct of a range of on-farm growth performance trials.*
- *To conduct a feasibility study of the transfer of the YY male technology to other countries in the region through transfer of fish to Thailand and initiation of breeding programmes in collaboration with partner institutes in Thailand.*

The first phase of the project was to scale up the production of GMT through the generation of large numbers of YY male and normal female broodstock, and the optimization of intensive hapa based hatchery techniques. At the beginning of the project only 30 YY males were available, enabling consistent production of approximately 40,000 GMT per month. With the availability of YY males from YY x YY matings, a further 260 YY males were added towards the end of the project producing >150,000 GMT fry in the final month of the Project, exceeding target production.

Following the commencement of GMT production, the testing of growth and economic performance of GMT in Philippine farm environments was initiated. This was principally to determine whether gains observed in on-station trials could also be obtained on-farm, where it is more difficult to control external factors (such as immigration) that might reduce or eliminate the likely benefits of culturing GMT. The performance of GMT was compared with that of farmer's fish (mixed sex or sex reversed males of Philippine strains of comparable age and size) in near identical culture units on each farm, utilising the farmer's normal management regimes. In several cases sex reversed male fish proved to have sex ratios significantly lower than those of the GMT, confirming that the YY male technology can be a considerably more reliable method for production of monosex fish than the technology of sex reversal.

Trials were initiated on 32 different farms throughout the tilapia growing regions of the country, representing the commonly used culture systems in the Philippines (predominantly ponds, cages and tank, in order of importance). There was a high failure rate for numerous reasons beyond our control, including fish lost as a result of typhoons, theft, holed cages etc., and only 18 trials were complete by the end of the project, with four still on-going. Nevertheless, these trials did produce sufficient data for analysis and for firm conclusions to be drawn.

The on-farm trials confirmed that GMT has very considerable benefits for aquaculture. GMT produced significant improvements in all commercially important harvest characteristics including growth, survival, yield, food conversion and uniformity of harvest size. These differences were clearly apparent (although not always statistically significant) between GMT and both MST and SRT. The magnitude of gains shown by the culture of GMT were similar for all environments, somewhat surprisingly in the case of cages, in which it had be anticipated that GMT would have a lesser advantage. The following table summarises the percentage differences of important harvest characteristics between GMT and MST or SRT across all environments.

Characteristic	GMT *vs.* MST	GMT *vs.* SRT
Harvest weight	25.7 *	20.3 ns
Survival	11.9 ns	9.6 ns
Percentage male	57.7 **	34.9 ns
Coefficient of variance for harvest weight	-9.6 ns	-14.4 **
Food conversion ratio	-14.6 *	-7.4 ns
Yield per cropping	36.9 ***	29.1 ***

ns - not significant; * - $P < 0.05$; ** - $P < 0.01$; *** - $P < 0.001$.

Economic data (costs of feed, fingerlings, labour, services etc.) was collected on all farms, with GMT costed at the prevailing local price for the control fish. The increases in net returns varied widely but the pooled average increase in net returns compared to controls was very consistent across ponds, cages and tanks ranging from 116 to 125%.

A secondary objective of the project was to conduct a feasibility study on the transfer of the YY male technology to another country, namely Thailand, which also has a thriving tilapia culture industry. Genetically modified fish (putative YY males and females and XX males and females) were transferred to Thailand from the Philippines. These were used in the evaluation of three alternative methods of transfer:

1. Direct: Producing GMT in the Egypt-Swansea strain transferred.
2. Indirect: Producing F_1 hybrid (with the option of subsequent backcrossing to the Thai strain) GMT between the Egypt-Swansea and Thai strains.
3. Development Anew: Developing YY males in the Thai strain.

Data showed that all these approaches are possible, although with respectively increasing investment of resources required. The direct option proved to be the simplest, cheapest and quickest method. Results from development of indirect approaches revealed that sex ratios of F_1 hybrid GMT and GMT resulting from F_1 hybrid YY males, were lower than predicted based on the results from previous work within the Egypt-Swansea strain (for example hybrid F_1 hybrid GMT had mean sex ratios of only 89-93% male). Some progress was made in developing

YY males only within the Thai strain but YY males could not be identified within the timescale of this project.

Preliminary growth trials revealed that monosex fish (as either GMT or SRT) of the Thai strain, and to some extent of the F_1 hybrids, grew significantly faster than those of the Egypt-Swansea strain in Thai environments. This indicated that the latter strain may be have an inferior growth performance, possibly due to local adaptation of the Thai strain. If sex ratios can be optimized, it seems likely that some form of indirect transfer would be the most appropriate means of transferring this technology from the Philippines to Thailand.

The major outputs of this project include a unique data set from on-farm trials of genetically modified tilapia in developing country culture systems. The results from these trials clearly indicate that there are very significant production and economic gains to be made from disseminating the products of the research and development work on the YY male technology. The techniques, facilities, and manpower developed under this project will enable this to commence without delay. It is essential that the mechanisms be developed to disseminate this technology widely throughout the Philippines and the region and development of such mechanisms are well underway at the time of writing.

Dr. Graham C. Mair June, 1995.

Introduction

Tilapia, principally of the genus *Oreochromis,* are exceptionally well suited to domestication and aquaculture and are now farmed extensively over most of the tropics especially in Southeast Asia. Although tilapia culture in the region, especially in the Philippines, is presently in a phase of expansion, the industry faces a number of persistent problems which limit its expansion, its productivity and its profitability. Principal problems facing the further expansion of the tilapia culture industry are:

(i) The poor genetic quality of most cultured strains. Many of these strains actually exhibit inferior growth performance, after several generations of domestication, when compared to wild caught strains.

(ii) The shortfall in supply of fry for grow-out. In the Philippines fry production is concentrated in only one or two areas of the country and breeders are estimated to produce only 50-75% of the national requirement (approximately 1 billion fry *per annum*).

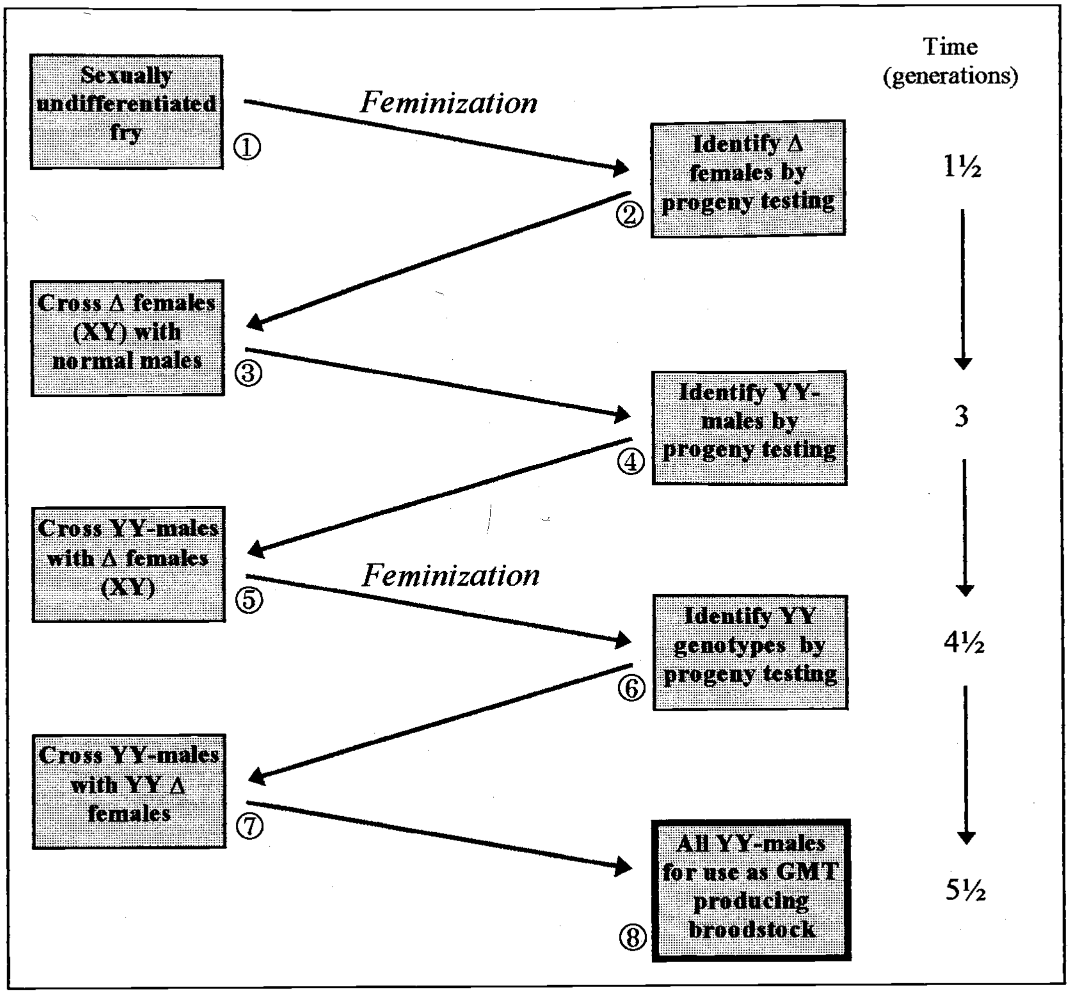
(iii) The problem of early sexual maturity and unwanted reproduction in ponds. This has long been accepted as a major constraint to the further development and expansion of tilapia culture. This reproduction leads to excessive recruitment, particularly in pond populations, resulting in competition for available food and space resources. Often the result of this is that 30-50% (and even up to 85%) of the biomass at harvest can be made up of largely unmarketable recruits.

Background Information

Whilst consideration is given to the first two mentioned above, the major emphasis of this project was on the problem of unwanted reproduction. Several practical solutions have been proposed for this problem including manual sexing, use of predators to cull fry, and prevention of spawning in cages. However, the most effective solution is the production of monosex male populations. Male tilapia have a faster growth rate than females as less energy is diverted into gamete production. All-male tilapia have been produced by hybridization (some interspecific crosses give high percentages of males in their progeny) or by direct sex reversal (feeding of androgens to sexually undifferentiated fry). Both these techniques have significant disadvantages. Hybridisation results in loss of species purity and in many hybrid crosses the sex ratios do not have consistently high proportions of males. Sex reversal is more successful and is used widely in some developed countries but has yet to be extensively adopted in developing countries. Apart from the danger of farmers using toxic substances in the production of food fish, and the need for additional facilities, the success of sex reversal has been quite variable, especially in developing countries. This is due to the number of factors that have to be closely controlled during the application of the hormone treatment such as initial age and size of fry, stocking density, concentration of hormone, frequency and duration of feeding, availability of natural food, etc. To date there is no universally effective and practical technology for the production of monosex male tilapia.

Based on previous ODA funded research on the genetics of sex determination in tilapia species (R.3679), carried out at the University of Wales Swansea, a model was proposed for the production of monosex male tilapia by genetic manipulation of sex in *O. niloticus*. Studies revealed that sex determination is predominantly monofactorial, similar to that in humans, where the female has the homogametic genotype XX and the male is heterogametic XY. It was proposed that, by sex-reversal (to female) followed by progeny testing (i.e. to determine the genotype of a fish by the sex ratio of its progeny), it would be possible to identify sex reversed females (Δ♀♀) with male genotypes (XY). These Δ♀♀ could then be crossed with normal males (effectively crossing two males). The progeny of this cross would contain approximately ¼ of the novel genotype YY. These can be identified by the all-male sex ratio of their progeny in crosses with normal females (XX x YY gives only XY male progeny). Further crosses of YY males with Δ♀♀ followed by a second generation of sex reversal could produce YY females which could then be crossed with YY males for the production of all-male producing YY male broodstock. This technology, the development of which is summarised in Figure 1, should take 5½ generations to complete (approximately 3-4 years), with the end product of broodstock that could be used by hatcheries to mass produce large numbers of Genetically Male Tilapia (GMT) for culture.

Figure 1 Schematic diagram depicting the model for large scale production of monosex male tilapia.



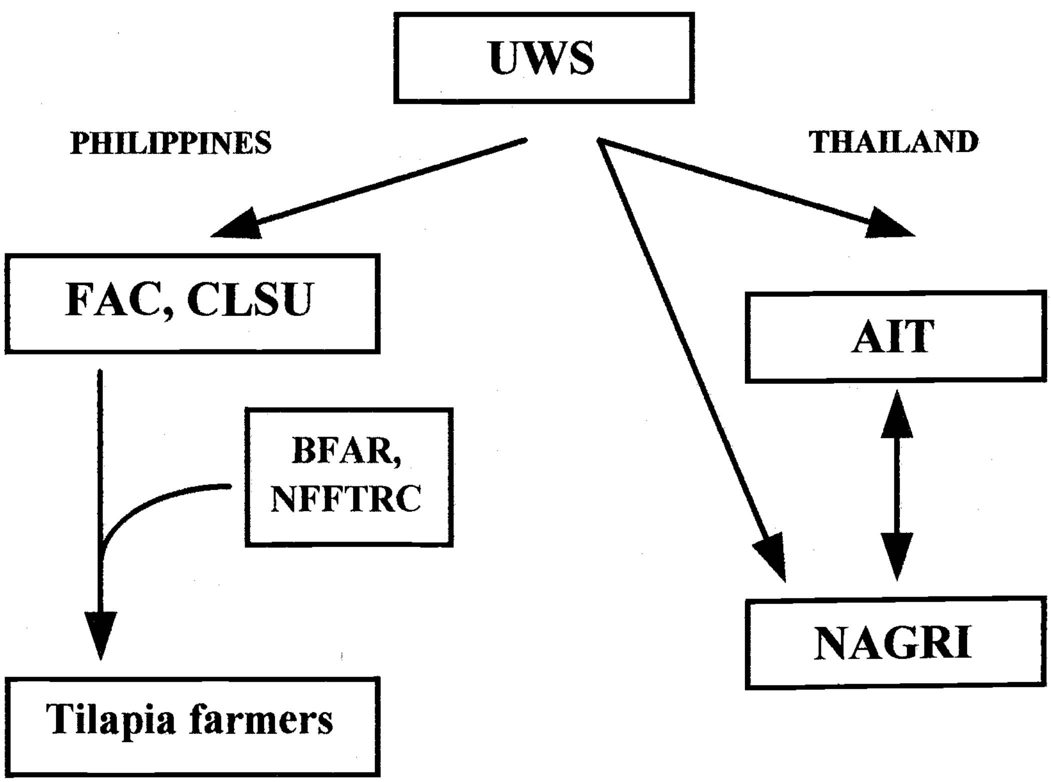
Breeding work conducted in the Philippines under ODA funded strategic research projects (R.4452 and R.4803) was successful in completing this programme, eventually enabling the production of YY males in YY x YY matings although the project reported here was initiated before it was determined that YY males could be successfully sex reversed to female through optimization of feminization techniques. The preceding strategic research projects demonstrated that YY males have a viability and fertility equivalent to normal males in at least two strains of *Oreochromis niloticus*. These YY males have produced genetically male progeny (given the acronym "GMT") with phenotypic sex ratios ranging from 67 to 100% male with a mean of approximately 96%. These projects also conducted some on-station growth performance trials which demonstrated very significant increases in yield over both sex reversed male (SRT) and mixed-sex populations (MST). In within strain comparisons using the Egypt-Swansea strain, GMT increased yields by 23 and 34% respectively over SRT and MST. It is also evident that the Egypt-

Swansea strain (see Annex 2 for details of strains nomenclature), in which the YY male technology has been furthest developed, has superior growth and survival characteristics to those of commercially cultured strains in the Philippines. Growth comparisons with these commercial strains demonstrated that GMT produced yields 28% and 51% greater than commonly cultured SRT and MST, respectively.

Interestingly, despite the presence of small proportions of females in GMT populations, no reproduction occurred, and it is evident that these few rare females exhibit delayed sexual maturation and therefore pose little problem in relation to recruitment in cultured populations.

This project was established primarily to conduct adaptive\field research related to the application of this technology in the tilapia culture industries of developing countries. The project was coordinated by the School of Biological Sciences, University of Wales, Swansea and was conducted in principal collaboration with the Freshwater Aquaculture Center of Central Luzon State University in the Philippines. The Philippine Bureau of Fisheries and Aquatic Resources (BFAR), through its National Freshwater Fisheries Training and Research Center (NFFTRC) acted as a secondary collaborator in the Philippines.

Organizational Structure of the Project



The work in Thailand was conducted in collaboration with the School of Environment Resources and Development of the Agricultural and Food Engineering Program of the Asian Institute of Technology (AIT) and the National Aquaculture Genetics Research Institute (NAGRI) of Thailand Department of Fisheries.

Objectives

The project had two broadly defined objectives.

- *To test the feasibility of large scale production of genetically male tilapia (GMT) and determine their potential impact for Philippine tilapia farmers through the conduct of a range of on-farm growth performance trials.*
- *To conduct a feasibility study of the transfer of the YY male technology to other countries in the region through transfer of fish to Thailand and initiation of breeding programmes in collaboraion with partner institutes in Thailand.*

Production and on-farm testing of GMT in the Philippines

This part of the programme had the following specific objectives:

1. To produce genetically manipulated fry for transfer to Thailand.
2. To develop intensive fry production facilities at FAC\CLSU to enable production of up to 1 million monosex fry per year by the end of the project.
3. To produce and identify large numbers of YY males for use as all-male producing broodstock.
4. To optimize fry production with limited numbers of YY males and determine relative fecundity of YY and XY males.
5. To work with national institutions (CLSU and BFAR) to identify a minimum of 20 cooperator farmers willing to conduct on-farm trials of genetically male tilapia (GMT).
6. To collate empirical information and on-farm observations to determine the potential benefits of culture of GMT.
7. If sufficient quantities of YY males can be produced, to conduct limited trials of these as broodstock in on-site and on-farm trials (with cooperator hatchery operators).

Feasibility study on the transfer of the technology to Thailand

Specific objectives for this part of the research programme were as follows:

1. To quarantine and on-grow and progeny test potential YY males received from the Philippines
2. To advise on the design of intensive production facilities at CLSU
3. To investigate the feasibility of methods of transferring the YY male technology into the Thai (Egypt-AIT or "Chitralada") strain by crossing YY males from the Egypt-Swansea strain, with females from the Egypt-AIT strain and backcrossing these progeny to the Egypt-AIT strain.
4. Investigate the sex ratios produced by YY males of the Egypt-Swansea strain crossed with females of the Egypt-AIT.
5. Compare growth rates of "monosex" inter-strain hybrids with androgen sex reversed populations of the Thai strain.
6. Based on the results from performance trials, to build up stocks of appropriate parental genotypes for production of monosex male populations.

Research Progress

Generally research has progressed very well with almost all objectives of the project being met. The results from the research have contributed very significantly to our understanding of the potential benefits of the application of the YY male technology, which appear to be considerable indeed. A number of problems did arise with the work. GMT fry production was maintained at consistent levels throughout the project and provided sufficient fry for stocking of 32 trials on farm. However YY females were produced quite late in the course of the strategic research project (R.4803) and so it did not prove possible to conduct any trials of YY male broodstock. This activity was turned over to a further adaptive project (R.6079A) which overlapped with this project in 1994\95. There was a high failure rate of on-farm trials for a number of unavoidable reasons, with the result that only 18 trials were complete by the end of the project, with a further three to be completed. Nevertheless, these completed trials provided excellent data sets, with consistent indicators as to the obvious benefits that can arise from the introduction of GMT to Philippine tilapia farms.

The work in Thailand was equally successful. Significant progress was made in evaluating the feasibility of alternative methods of technology transfer enabling informed decisions to be made on how this could best be achieved in Thailand, and other countries in the region.

On-station production of GMT and on-farm testing in the Philippines

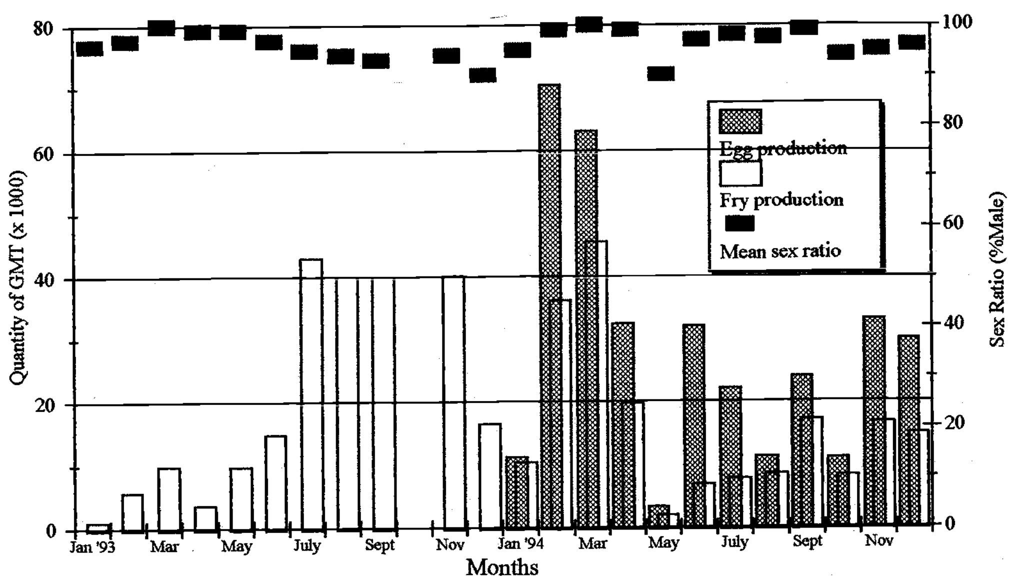
During the initial phase of the project we concentrated on increasing production of GMT by generating further YY male and normal female broodstock and by optimizing production from the broodstock that were available. On-farm trials began only when GMT were being consistently produced in sufficient numbers.

On-station production of GMT

The identification of large numbers of YY males

Early in 1993 a total of 30 YY males were turned over to the project, following identification by progeny testing under R.4803. These were stocked in hapas, with normal females (XX) of the Egypt-Swansea strain at a ratio of 1 male to 4 females. During 1993 the less intensive and productive technique of fry collection (every 14 days), rather than egg collection was employed. At the beginning of 1994 we converted to seven day collections, from which the number of eggs could be determined. Figure 2 shows the egg and fry collection data from these 30 YY males throughout 1993 and 1994.

Figure 2. Graph showing monthly production of egg and fry production of GMT from 30 YY males throughout 1993 and 1994. Mean sex ratio of the GMT produced in each month is also shown.



Peak fry production was approximately 40,000 per month, equivalent to 1,300 per YY male, per month, which can be considered highly productive. Table 1 shows the production throughout 1994 when intensive hapa based hatchery techniques were being used. This illustrates the highly variable survival rates for incubation of eggs up to fry, ranging from 21- 93%, with an average of less than 50%. Problems of optimization of incubation plagued the production throughout the year and limited the average production to only 15,900 per month, equivalent to 500 per YY male.

Table 1. Egg and fry production from an intensive hapa based hatchery for GMT.

Month	No. of eggs	No. of fry	% Survival eggs to fry	% Male (mean of all collections)
1994				
January [a]	11,222	10,450	93.12	95
February	70,426	36,150	51.33	99
March [b]	63,122	45,700	72.39	100
April	32,478	19,700	60.65	99
May	3,350	2000	59.70	90
June	32,054	6,800	21.21	97
July	22,054	7,750	35.14	98
August	11,158	8,600	77.07	97.5
September	24,000	17,100	71.25	99
October [c]	10,950	8,300	75.79	94
November	33,107	16,700	50.44	95
December	29,968	15,000	50.05	96
1995				
January	29,182	12,400	42.49	

a - Production started only in mid January so only two collections are represented.
b - Noted to be the start of the rainy season. The data represents one week of the production because the males were conditioned.
c - The data only represent two weeks production because the males were conditioned

As a result of the developments from the later research conducted under R.4803, YY males could be crossed with known YY females. Four YY x YY crosses were made and a total of 61 males and 12 hormone treated females were progeny tested as shown in Table 2. These results confirmed that YY x YY crosses do indeed yield only YY male progeny and thus that they can be mass produced in this way. The 61 YY males tested produced family sex ratios ranging from 79.5 to 100% male with a mean of 98.9%.

Table 2. Summary of progeny testing for putative YY males (crossed to normal XX♀♀) and YY females (crossed to sex reversed XXΔ♂♂) in progeny from YYΔ♀ x XY♂.

Summary Parameter	YY Males	YY Females
No of families from which males were tested	4	3
Number of putative YY genotypes tested	61	12
Number of progeny sexed (mean per family)	3,723 (61.0)	652 (54.3)
Number of males classed as YY (%)	61 (100.0)	12 (100.0)
Expected number of YY males (%)	61 (100.0)	12 (100.0)
χ^2 value of observed *vs.* expected no. of YY males	0.0	0.0
Range of sex ratios from YY males	79.5 - 100.0	100.0
Mean of sex ratios from YY males (± SD)	98.9 (± 3.1)	100 (± 0)

As a result of this, a total of 260 YY males were turned over to the project in January 1995 and used in production of GMT for the last 3 months of the project. Figure 3 shows the production from these 260 YY males, again illustrating the high rate of losses from egg, to hatchling and hatchling to fry. Nevertheless a total of 170,000 fry were produced in March, equivalent to an annual production of over 2,000,000 thereby more than doubling the stated target (see page 12). Egg production was in excess of 350,000 per month.

In order to attempt to improve fry production from intensive hapa based hatcheries, an experiment was initiated to optimize the collection intervals for fry. The effect of frequency (every 3.5, 5, 7, 10, 14 days) of seed (egg, yolksac fry and swim-up fry) collection on the production of *O. niloticus* fry in hapa-based system was evaluated for a duration of 90 days. The whole experiment was repeated during the warm season (April-June) and the cool season (Dec.-Feb.) of 1994\95. Collected eggs were artificially incubated in a downwelling incubation system. Table 3 and Table 4 show the seed collected, number of females spawning, and resulting fry production for the different collection intervals.

Figure 3. Graph showing production of eggs, hatchlings and fry over the first three months of 1995.

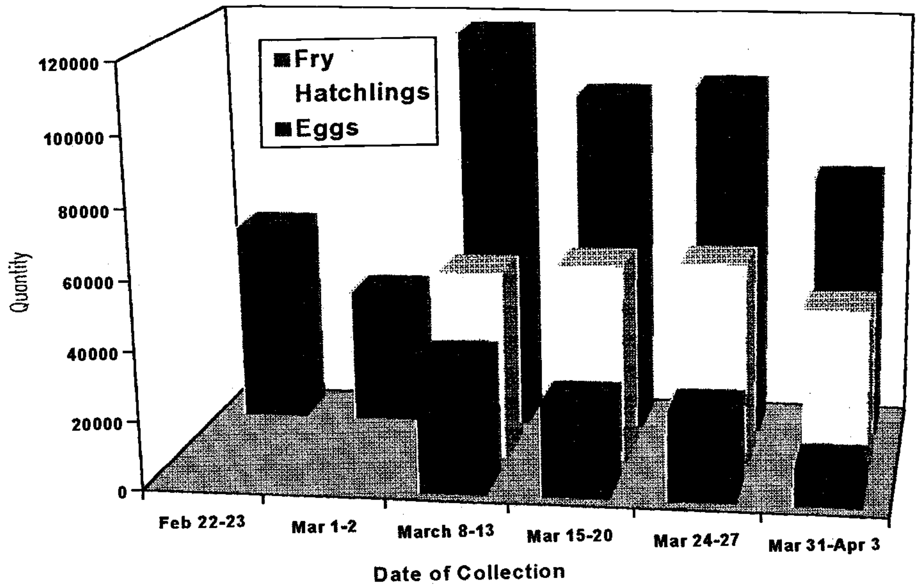


Table 3. Mean (± SD) seed collection, number. of spawnings and fry produced under five different collection frequencies for hapa based fry production (warm season)

Collection interval	Seed production at collection	No. of spawnings	Fry produced
3.5	35.7^{b} (±9.0)	42.0^{a,b}(±12.0)	13,3^{a}(±6.2)
5	43.9^{a} (±6.6)	54.7^{a} (±9.0)	18.8^{a} (±4.2)
7	26.4^{c} (±4.2)	34.0^{b,c} (±4.4)	10.7^{a} (±1.3)
10	13.8^{d} (±2.5)	22.7^{c,d} (±4.2)	8.5^{a} (±1.0)
14	15.6^{d} (±3.7)	20.3^{d} (±4.7)	8.9^{a} (±4.0)

Seed collection and fry production x 10^3. Means within a column superscripted with different letters are significantly different (P<0.05)

Table 4. Mean (± SD) seed collection, number. of spawnings and fry produced under five different collection frequencies for hapa based fry production (cool season)

Collection interval	Seed production at collection	No. of spawnings	Fry produced
3.5	24.4^{a} (±6.8)	37.0^{a} (±9.8)	11.6^{a} (±4.1)
5	21.1^{a} (±1.2)	32.0^{a} (±4.4)	10.2^{a} (±2.8)
7	18.2^{a} (±8.0)	27.3^{a} (±11.5)	11.5^{a} (±4.3)
10	19.0^{a} (±5.0)	31.7^{a} (±9.8)	12.,^{a} (±1.9)
14	15.2^{a} (±3.9)	23.3^{a} (±3.5)	10.8^{a} (±2.3)

A total of 60 breeders were used in each treatment, consisting of three replicate spawning units of five males and 15 females. Overall levels of seed production were greater during the warmer season and there was a clear trend indicating maximum seed collection for the shorter intervals of 3.5 and 5 days. These differences were significant($P < 0.05$) during the warm season but not during the cooler season. This increased seed collection was largely due to the increased number of spawnings obtained with the more frequent collections. The study showed that productivity of broodfish can be increased by early seed removal from the female and artificial incubation of the seed. The removal of the seeds from the mouth-brooding females shortened the average time period between spawnings. The slightly lower seed production in 3.5 day collections, compared to 5 day, may be due to inhibition of spawning as brought about by the too frequent collection.

There were however no significant differences in fry production among the treatments and this was quite consistent for all treatments, especially during the cool season. This may be due to the higher mortality during incubation for the eggs collected at the shortest intervals, presumably because of the relatively higher proportion of un-eyed eggs in these collections.

Thus it is apparent that in intensive systems, production of fry relies heavily on the design and efficiency of the artificial incubating system. Given optimised incubation systems, which ours were clearly not, a collection interval of five days seems likely to yield the highest fry production. If incubation systems are sub-optimal, longer collection intervals are recommended to maximize fry production with minimal labour.

Conduct of on-farm trials - Principles and Practices

The GMT fry produced on-station were used for stocking on farm trials. The principal objective of these trials was to assess the performance of the GMT, compared to fish presently used by farmers, in a range of Philippine on-farm environments. These growth performance trials would be conducted under less controlled conditions than our previous on-station trials (under R.4803) and may highlight some limitations in the use of GMT in farm situations. A total of 32 farms were identified using industry contacts of the Bureau of Fisheries and Aquatic Resources and CLSU. Some selection criteria were applied in the identification of cooperator farmers. Farmers operating what could be regarded as "typical" tilapia culture practices were preferred and we tried to identify the classes of cooperator (pond, cage, tank etc.) according to their priorities in Philippine tilapia culture. The control used in these trials was intended to be the fish that the farmer was accustomed to use, whether it was simply the restocking of recruits from his previous harvest, or purchased from a hatchery (either mixed sex or sex reversed male). In some cases the farmer had no typical fish or was unable to obtain suitable fish in which case we also provided fish of the most commonly cultured Philippine strain (Ghana-BFAR). As far as was possible the GMT and control fish, irrespective of source, were matched for size and age.

Annex 4, Tables 1, 2, and 3, provide details of the farms selected for testing of GMT including area (volume) of culture units, number and density of fish stocked and the length of culture period. Further details of each completed trial are given in the farm fact files in Annex 3 of this report. Eighteen pond farms were selected for these trials, of which seven were successfully completed, seven failed and four are still on-going at the time of writing. Intensity of culture in ponds varied with stocking densities ranging from 2 to 7½ per m^2. Four of the seven completed trials applied supplementary feeding. In six of the seven completed trials the control fish were SRT purchased from commercial hatcheries. This is not representative of the general situation for pond aquaculture (probably less than 15% of pond farmers use SRT) and reflects a bias in our selection of cooperator farmers, those we knew in Central Luzon being perhaps more technically aware and also having access to SRT producing hatcheries in the area.

Six out of nine trials stocked in cages were successfully completed, the remaining three failing. Levels of intensity also varied with stocking density ranging from 3.5 to 25 per m^2. As fish growth in cages cannot be sustained by natural food production alone, all cage grown tilapia were fed. Only one of the cage farmers regularly used SRT, MST were used as the control fish in the remaining farms. This reflects a lower level of awareness of the potential benefits of SRT among cage farmers, recruitment and overpopulation not being a problem for this sector of the industry.

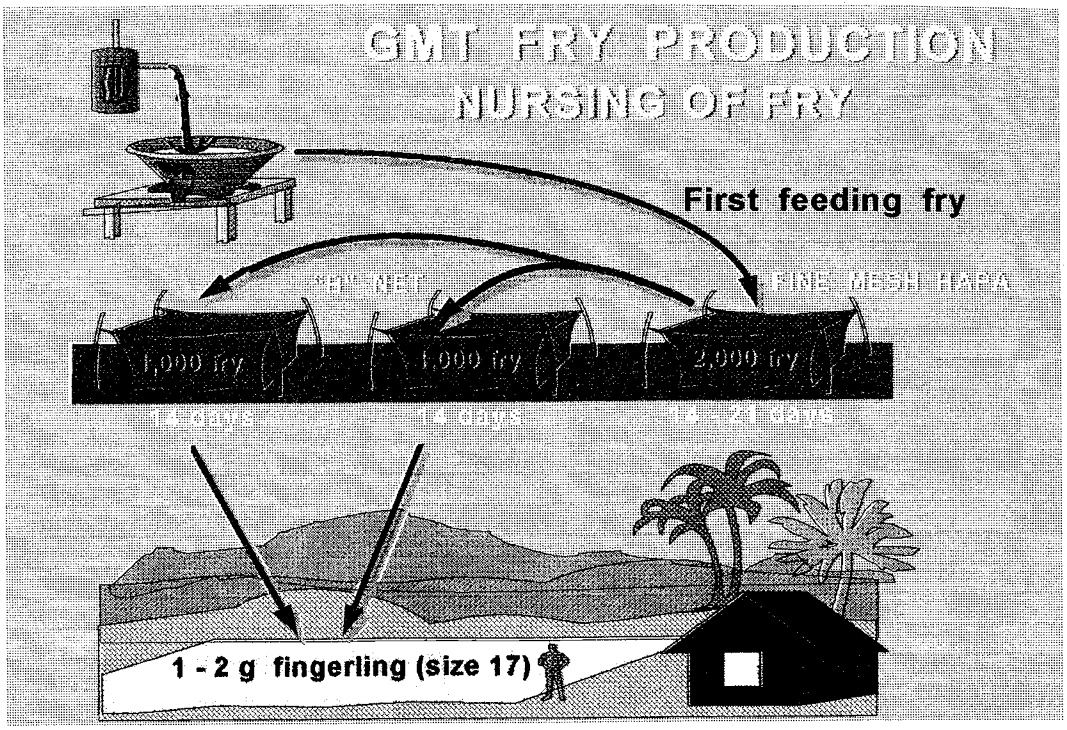
The former two environments are those most common in Philippine tilapia culture (approximately 60% of tilapia production comes from ponds and more than 30% from cages). One trial was conducted in a rice-fish environment (fish were stocked in a trench adjacent to a rice-field, with access to the field itself) and another in polyculture with African catfish (*Clarias gariepinus*), both using MST as control fish. The remaining three successful trials were in concrete tank systems, representing fairly intensive culture, all using SRT, which are perceived to be of greatest value in intensive culture.

Failures occurred for varying reasons including loss of fish due to natural disasters (typhoons and flooding), theft of fish, loss of fish due to holed cages, and farmer's terminating experiments ahead of schedule due to economic needs, and usually without advanced notice.

The following describes the methodology for the conduct of the on-farm trials part of which is depicted in Figure 4:

- An initial farm visit was made to assess suitability and to schedule fingerling release
- GMT fry were collected to match the size and age of farmer's fish
- If numbers were not too large, GMT and controls were marked by fin clipping
- One week before release of fingerlings, the GMT (and control if necessary) were transported to the farm and stocked in cages under identical conditions, to remove any bias caused by compensatory growth
- A representative sub-sample of fish were weighed and measured and fingerlings released
- Farmers applied their normal management procedures, although they were requested to screen water inlets if necessary, to prevent influx of feral fish
- Farmers scheduled the harvest according to their own needs
- At harvest a sample of 20% of the fish were individually weighed and measured, up to a maximum of 500. Remaining fish were bulk weighed as were any recruits present
- Economic data was collected based on farm records and sales of fish.

Figure 4. Graphical depiction of process of GMT production, prior to stocking on farm.



Production data from performance trials of GMT

Annex 4, Tables 1, 2 and 3 provide details of the production data gained from the 18 completed trials. Data collected for each trial included:

- Harvest weight (g) - As there were no significant differences in initial weight (at stocking) direct comparisons within each trial, of harvest weight were considered valid.

- Percentage survival - $\dfrac{\text{Number harvested}}{\text{Number stocked}} x\ 100$

- Percentage male at harvest - $\dfrac{\text{Number of males}}{\text{Total number}} x\ 100$

- Coefficient of variation for weight - $\dfrac{\sigma \text{ of harvest weight}}{\text{Mean of harvest weight}} x\ 100$

- Food conversion ratio (FCR) - $\dfrac{\text{Total weight of food administered}}{\text{Harvest biomass - stocking biomass}}$

- Yield (kg per cropping) - Biomass of harvested stocked fish after the allotted period of grow out.

- Yield (kg\m^{-2}\day) - Biomass of harvested stocked fish converted to standard per unit area per day.

Results

In pond culture (Annex 4, Table 1), harvest sizes ranged from 43g up to 191g (representing the range of marketable sizes), with a mean of 106g for controls and 131g for GMT. In the case of the smallest fish (PSU), harvest was earlier than planned due to water supply problems. Yields varied from 0.4 to 5.1g per day reflecting the different stocking densities and intensities of culture practices.

In cage culture, harvest sizes were larger than in the other environments ranging from 57.0 to 308.0g with a mean of 141g for controls and 164g for GMT. Yields ranged from 2.5 to 22.1 g\m^3\day

As expected, due to the short grow-out period, the harvest weight (33.6g and 49.3g for MST and GMT respectively) and yield (0.12 and 0.17 g\m^2\day respectively) were very low under rice-fish culture. Although the harvest weight of the catfish was 50% greater in the GMT treatment there was no significant difference in the yield of catfish in the CRSP polyculture trial and growth and yields of tilapia approximated to those observed in similar monoculture pond trials. Harvest sizes were greater in tanks than in ponds ranging from 104.0 to 215.0g, with means of 139.0 and 158.0g for controls and GMT respectively. Yields ranged from 4.1 to 8.4 g\m^2\day.

Mean survival from stocking to recruitment was highest in tanks and lowest in cages. FCR was highest in cages due to the reliance on supplementary feeding and the absence of natural productivity on which the fish could graze. Over all environments, harvest sex ratios of MST ranged from 45.0 to 86.5% male and averaged 63.8%, somewhat skewed to male. Sex ratio of SRT was highly variable ranging from 46.8 to 100% male with a mean of 78.2. These SRT were all commercially produced and these observed sex ratios reflect the unreliability of this technique for the production of monosex populations. Given the commonly accepted minimum effective sex ratio for SRT of 95.0% male, only three of the eight farmers received satisfactorily sex reversed fish.

Figure 5 Map Showing location and farm type for on-farm trials in Luzon

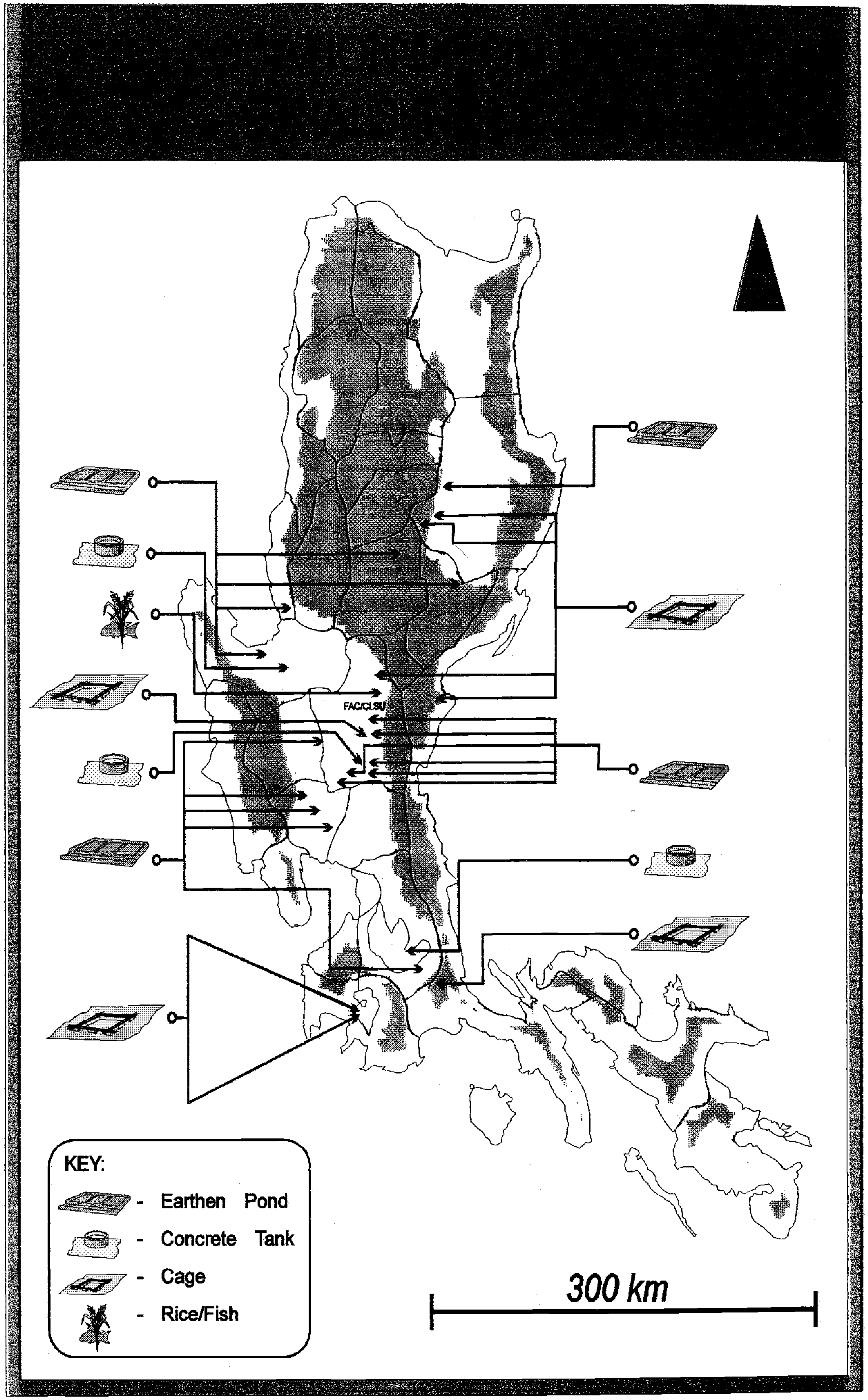
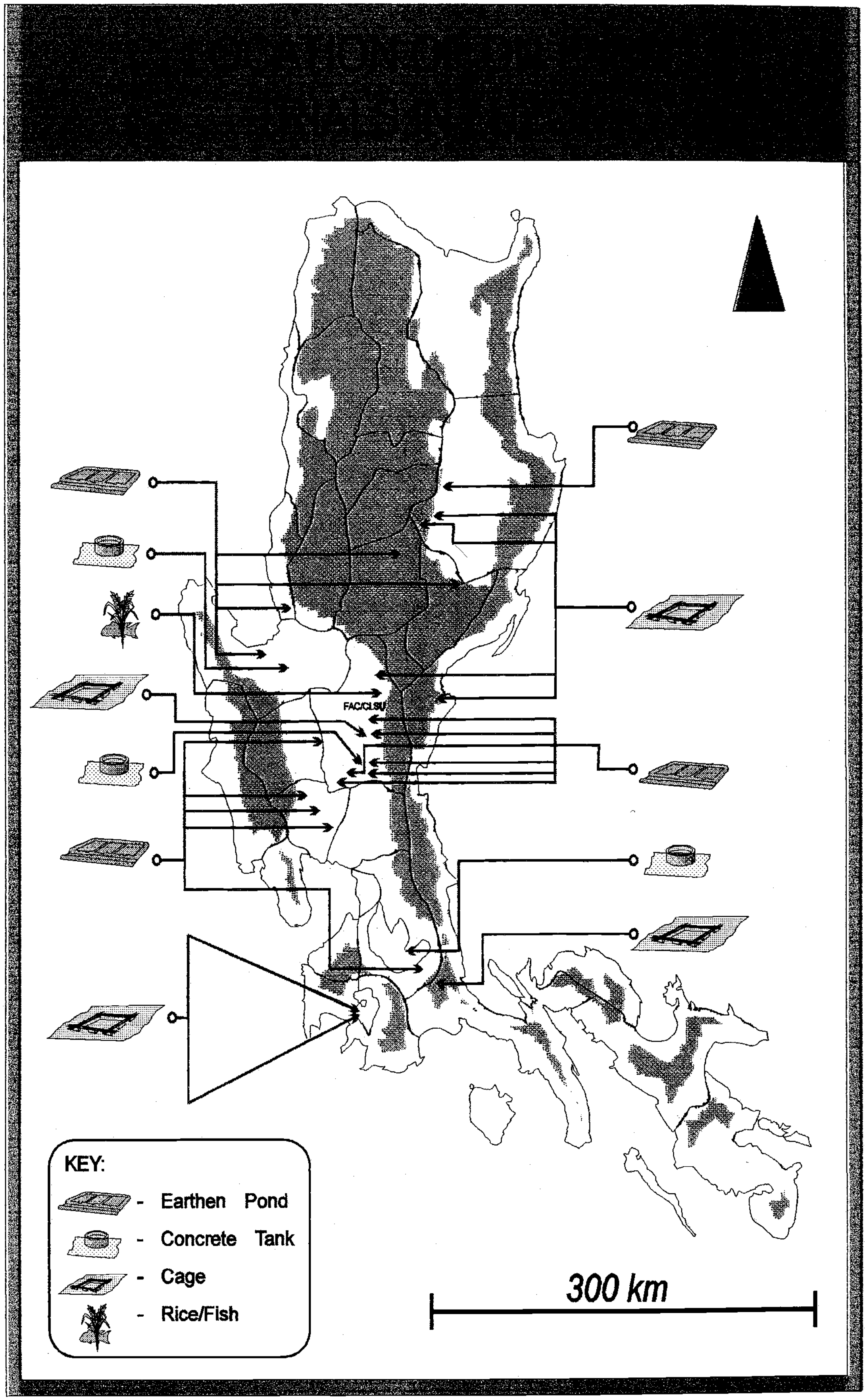


Figure 5 Map Showing location and farm type for on-farm trials in Luzon



This emphasises the serious problems in the application of this technique in developing country conditions. Sex ratios of GMT were much more consistent ranging from 90.0 to 100% male with a mean of 96.5%, demonstrating that the high sex ratios observed in our on-station trials can be repeated in the supply of fish to farmers. This indicates that the unwanted immigration of females into farmed tilapia populations may not be a serious problem in the application of the YY male technology.

Table 5, Table 6 and Table 7 show the comparative values for eight harvest characteristics of GMT and control populations respectively for pond, cage and other environments. These tables show comparisons separately for GMT *vs.* MST and SRT and for the two control types combined as GMT *vs.* control. These percentage differences were tested against the hypothesis of equality using a paired sample t-test. Means (±s.e.), 95% confidence intervals, probability and levels of significance are given in these tables.

Table 5 summarises the comparisons from ponds, most of which were made with SRT as controls. GMT had higher harvest weight, survival, sex ratio, yield and net returns and lower CV for weight and FCR than the SRT. Due to the poor sex reversal in the commercial SRT used in these trials, the most relevant comparison is that of GMT *vs.* controls. Over the seven trials, comparative differences in harvest weight, sex ratio, and yield were significant, highly so in the case of yield.

Table 6 shows the comparisons from cages. These comparisons were made mainly with MST although it should be noted that the SRT used in one of the trials did have a very high percentage male, comparable with that of the GMT. In comparison with the MST, GMT had very similar trends those seem in the pond comparison but only percentage male was significantly higher ($P<0.05$) for GMT, all other comparisons were not significant. However, with the inclusion of the data from the SRT, the yield per cropping was significantly greater for GMT.

Table 7 shows the comparisons for tanks. Here three of the four comparisons were with SRT. Again these trials showed similar trends, with GMT have higher harvest weight, survival, sex ratio, yield and net returns, and lower CV of weight and FCR. Only the difference in survival was significant but the small number of trials reduced the value of these comparisons. With the addition of one comparison with MST, the differences in yield were also significant ($P < 0.05$).

Table 8 shows comparisons of GMT with MST and SRT across all environments, with a total of 19 comparisons from 18 trials. In ten comparisons with MST and nine with SRT, GMT produced average increases in harvest weight of 25.7% and 20.3% respectively. Similarly survival of GMT was 11.9% and 9.6% greater than for MST and SRT respectively. The combined gain in harvest weight and survival resulted in highly significantly increased yields (per cropping) of GMT compared to MST (+36.9%) and SRT (+29.1%). GMT had sex ratios 57.7% greater than MST and the 34.9% increase over SRT confirms the deficiencies of sex reversal as a method for producing monosex tilapia.

Other important characteristics were also improved in GMT which had more uniform harvest weight and better food conversion ratios than both MST and SRT. Perhaps surprisingly, CV for weight in MST was only 9.6% lower than GMT, whereas SRT was 14.4% lower than GMT. GMT had food conversion ratios 14.6% lower than MST and 7.4% lower than SRT, demonstrating that the GMT populations appear to convert food more efficiently. These improvements of GMT all contribute to improved profitability in their culture and the mean improvement in net returns were indeed spectacular, averaging 494% compared to MST (although this was highly variable and therefore not significant) and 170% compared to SRT (P=0.022). When MST and SRT are combined as control fish, all comparisons were significant, very highly so in the case of harvest weight, survival, percentage male and yield.

Discussion

Culture of GMT appears to have very considerable advantages over both MST and SRT. Whilst it should be considered that some of these differences may be due in part to strain differences between the Egypt-Swansea strain, and the local Philippine strains, the GMT did exhibit improved characteristics for all the measured parameters. The sign of difference of GMT compared to MST and SRT was very consistent throughout all of the trials and the range of magnitude of the differences was less than had been expected given the great diversity of culture conditions. Perhaps more surprising is the great similarity between the results from ponds, cages, and tanks. It had been anticipated that the likely advantages of GMT would be greater in the confined environments of tanks and ponds than it would be in cages. Although females in cages do become sexually mature, spawning is difficult due to lack of suitable spawning media, and even if spawning does occur, recruitment does not. The results indicate that the advantages of GMT in cages are nevertheless similar to those in confined environments, indicating that perhaps the major component of this advantage is the differential growth of males and females and the interactions between the two sexes in MST and inefficiently sex reversed SRT. It is also possible that the Egypt-Swansea strain is better adapted to semi-intensive, high density, culture in cages, having been maintained for several generations in intensively managed recirculating systems. Based on previous results with sex reversed male populations, the higher harvest weight and yield of GMT compared to controls had been expected. Less expected was the higher survival of GMT populations. Although it was not possible to determine whether this improved survival was due to higher survival of genetic males or of the Egypt-Swansea strain, it can be recalled that GMT also had higher survival than MST and SRT in within strain trials (see final report on R.4803). Due to the degree of sexual dimorphism in size in *O. niloticus*, it is not surprising that GMT had lower coefficients of variation than the controls, although it is difficult to explain why the differences with SRT were greater than those with MST. This characteristic was noted with favour by farmers as it permitted them to market a larger proportion of their fish in one (the largest) size group and thus for a higher price, with less grading required. Again more surprising is the significantly lower food conversion ratios of GMT compared to both MST and to controls, considering that this analysis was based on a small number of samples (only those farms in which the fish were fed). This indicates that males convert food more efficiently than females as has been indicated by previous studies.

It is clear from this data, especially considering the relatively high levels of statistical significance of the difference of GMT compared to the farmer's control fish, that culture of GMT produced improvements in all important harvest characteristics. The improvements in harvest weight, survival (and thus yield), CV of weight and FCR all combined to produce spectacular increases in net returns which are discussed further in the next section.

Table 5. Comparative values of eight variables from the harvest of seven on-farm trials of GMT *vs.* MST or SRT in ponds. Differences between GMT and Controls (MST or SRT) expressed as a percentage of control value.

Character	GMT *vs.* MST (2)	GMT *vs.* SRT (5)	GMT *vs.* Control (7)
Harvest weight	Mean = 34.42 (±13.36) CI - 135.30, 204.15 P = 0.236 **ns**	Mean = 26.72 (±15.15) CI -15.37, 68.81 P = 0.153 **ns**	Mean = 28.92 (±10.95) CI - 2.12, 55.72 P = 0.038 *
Survival	Mean = 8.75 (±9.11) CI - -106.96, 124.47 P = 0.513 **ns**	Mean = 10.97 (±9.72) CI --16.02, 37.95 P = 0.322 **ns**	Mean = 10.33 (±7.01) CI - -6.81, 27.48 P = 0.191 **ns**
Percentage male	n\a	Mean = 68.62 (±17.83) CI - 11.88, 125.3 P = 0.031 *	Mean = 63.06 (±14.88) CI - 21.73, 104.40 P = 0.013 *
CV of weight	Mean = 10.27 (±22.55) CI - -273.31, 296.86 P = 0.73 **ns**	Mean = -15.69 (±4.08) CI - -28.67, -2.72 P = 0.031 *	Mean = -7.04 (±8.4) CI - -28.63, 14.56 P = 0.440 **ns**
FCR	n\a	Mean = -5.23 (10.33±) CI - -38.10, 27.63 P = 0.650 **ns**	Mean = -5.23 (±10.33) CI - -38.10, 27.63 P = 0.650 **ns**
Yield per cropping	Mean = 44.92 (±2.35) CI - 15.01, 74.84 P = 0.033 *	Mean = 36.09 (±5.37) CI - 21.16, 51.01 P = 0.003 **	Mean = 38.61 (±4.08) CI - 28.62, 48.60 P = 0.000 ***
Yield (kg\m²\day)	n\a	Mean = 32.27 (± 5.63) CI - 16.63, 47.91 P = 0.005 **	Mean = 37.33 (±5.08) CI -24.90, 49.76 P = 0.000 ***
Net returns	Mean = 1302.1 (±1198) CI - -13918, 16522 P = 0.47 ***	Mean = 198.8 (±96.60) CI - -69.51, 467.08 P = 0.109 **ns**	Mean = 514.02 (±337.9) CI - -313.0, 1341.1 P = 0.180 **ns**

Numbers in parentheses represent the standard error of the mean. CI is the 95% confidence intervals.

Table 6. Comparative values of nine variables from the harvest of six on-farm trials of GMT *vs.* MST or SRT <u>in cages</u>. Differences between GMT and Controls (MST or SRT) expressed as a percentage of control value.

Character	GMT *vs.* MST (5)	GMT *vs.* SRT (1)	GMT *vs.* Control (6)
Harvest weight	Mean = 26.66 (±16.49) CI - -19.13, 72.45 P = 0.180 **ns**	n\a	Mean = 27.50 (±13.49) CI - -7.18, 62.19 P = 0.090 **ns**
Survival	Mean = 9.61 (±10.12) CI - -18.51, 37.73 P = 0.400 **ns**	n\a	Mean = 8.51 (±8.34) CI - -12.93, 29.95 P = 0.355 **ns**
Percentage male	Mean = 52.25 (±17.99) CI - 2.29, 102.20 P = 0.044 *	n\a	Mean = 43.66 (±17.01) CI - 0.06, 87.40 P = 0.050 *
CV of weight	Mean = -4.39 (±6.99) CI - -23.80, 15.01 P = 0.560 **ns**	n\a	Mean = -5.80 (±5.88) CI - -25.96, 9.31 P = 0.369 **ns**
FCR	Mean = -14.29 (±5.81) CI - -32.79, 4.21 P = 0.091 **ns**	n\a	Mean = -12.44 (±4.87) CI - -25.96, 1.07 P = 0.063 **ns**
Yield per cropping	Mean = 33.93 (±12.37) CI - -0.44, 68.29 P = 0.052 **ns**	n\a	Mean = 29.14 (±11.18) CI - -0.40, 57.89 P = 0.048 *
Yield (kg\m^2\day)	Mean = 34.65 (±12.07) CI -1.12, 78.66 P = 0.080 **ns**	n\a	Mean = 29.72 (±11.02) CI -1.39, 58.06 P = 0.080 **ns**
Net returns	Mean = 317.1 (±171.46) CI - -159.13, 793.30 P = 0.138 **ns**	n\a	Mean = 266.5 (±148.86) CI - -116.27, 649.26 P = 0.133 **ns**

Table 7. Comparative values of nine variables from the harvest of three on-farm trials of GMT *vs.* MST or SRT <u>in tanks</u>. Differences between GMT and Controls (MST or SRT) expressed as a percentage of control value.

Character	GMT *vs.* MST (1)	GMT *vs.* SRT (3)	GMT *vs.* Control (4[1])
Harvest weight	n\a	Mean = 5.70 (±13.15) CI - -50.86, 62.25 P = 0.710 **ns**	Mean = 6.78 (±9.35) CI - -22.99, 36.57 P = 0.521 **ns**
Survival	n\a	Mean = 9.45 (±1.26) CI - 4.00, 14.90 P = 0.017 *	Mean = 9.06 (±0.97) CI - 5.95, 12.17 P = 0.003 ***
Percentage male	n\a	Mean = 1.50 (±0.89) CI - 2.31, 5.31 P = 0.233 **ns**	Mean = 16.41 (±14.92) CI - 31.09, 63.92 P = 0.352 **ns**
CV of weight	n\a	Mean = -12.54 (±8.91) CI - -125.78, 100.70 = 0.390 **ns**	Mean = -18.05 (±7.54) CI - -50.48, 14.38 P = 0.139 **ns**
FCR	n\a	Mean = -11.01 (±2.72) CI - -22.73, 0.71 P = 0.060 **ns**	Mean = -12.23 (±2.28) CI - -19.49, -4.97 P = 0.013 *
Yield per cropping	n\a	Mean = 25.38 (±9.87) CI - -17.07, 67.83 P = 0.124 **ns**	Mean = 24.16 (±7.08) CI - 1.63, 46.70 P = 0.042 *
Yield (kg\m^2\day)	n\a	Mean = 27.95 (±12.88) CI -27.51, 83.40 P = 0.162 **ns**	Mean = 25.96 (±8.89) CI -3.72, 55.64 P = 0.069 **ns**
Net returns	n\a	Mean = 175.38 (±86.73) CI - -197.79, 548.56 P = 0.181 **ns**	Mean = 169.29 (±61.63) CI - -26.84, 365.43 P = 0.071 **ns**

1 - One trial had both MST and SRT controls

Table 8. Comparative values of nine variables from the harvest of eighteen on-farm trials of GMT *vs.* MST or SRT across all environments. Differences between GMT and Controls (MST or SRT) expressed as a percentage of control value.

Character	GMT *vs.* MST (10)	GMT *vs.* SRT (9)	GMT *vs.* Control (19[1])
Harvest weight	Mean = 25.67 (±9.07) CI - -5.18, 46.21 P = 0.020 *	Mean = 20.27 (±9.58) CI - -1.82, 42.37 P = 0.067 **ns**	Mean = 23.13 (±6.43) CI - 9.61, 36.64 P = 0.002 **
Survival	Mean = 11.88 (±5.46) CI - -0.468, 24.23 P = 0.057 **ns**	Mean = 9.58 (±5.20) CI - -2.43, 21.58 P = 0.103 **ns**	Mean = 10.79 (±3.69) CI - 3.03, 18.54 P = 0.009 **
Percentage male	Mean = 57.67 (±12.35) CI - 28.45, 86.89 P = 0.002 **	Mean = 34.95 (±15.17) CI - -0.91, 70.83 P = 0.055 **ns**	Mean = 46.31 (±9.89) CI - 25.22, 67.40 P = 0.000 ***
CV of weight	Mean = -9.56 (±6.96) CI - -25.30, 6.18 P = 0.202 **ns**	Mean = -14.39 (±2.98) CI - -21.69, -7.08 P = 0.003 **	Mean = -11.54 (±4.21) CI - -17.88, -2.44 P = 0.014 *
FCR	Mean = -14.61 (±4.51) CI - -27.15, -2.07 P = 0.032 *	Mean = -7.38 (±4.98) CI - -19.15, 4.40 P = 0.182 **ns**	Mean = -10.15 (±3.54) CI - -17.88, -2.44 P = 0.014 *
Yield per cropping	Mean = 36.90 (±7.08) CI - 20.88, 52.92 P = 0.001 ***	Mean = 29.09 (±5.29) CI - 16.87, 41.30 P = 0.001 ***	Mean = 33.20 (±4.46) CI - 23.82, 42.58 P = 0.000 ***
Yield (kg\m²\day)	Mean = 27.54 (±10.10) CI -4.67, 50.41 P = 0.023 *	Mean = 27.81 (±5.58) CI - 14.93, 40.69 P = 0.001***	Mean = 27.66 (±5.78) CI -15.51, 39.82 P = 0.000 ***
Net returns	Mean = 494.95 (±241.5) CI - -51.44, 1041.33 P = 0.071 **ns**	Mean = 170.40 (±60.15) CI - -31.67, 309.14 P = 0.022 *	Mean = 341.21 (±133.5) CI - 62.71, 619.72 P = 0.019 *

1 - One trial had both MST and SRT controls

Economic data from performance trials of GMT

A simple cost and return analysis was performed to determine the profitability of producing GMT. In preparing for the analysis, cost estimates were based on actual expenditures incurred by the cooperators for the different production inputs such as feed, fertilizers and fuel/electricity. Labour expenses were estimated by considering both direct and inputted costs. The direct costs represent actual payments made for hired labour, while inputted costs (opportunity cost of labour) were estimated for work provided by the operators. Fingerlings which were actually provided free by the project, were valued at prevailing market prices. GMT fingerlings were valued at the same price as control fish irrespective of whether they were MST or SRT.

As an aside, at the end of the project, some GMT fingerlings were sold to buyers, without subsidy, at the standard market price for mixed sex tilapia (i.e. lower than that for SRT). It is thought likely that, in the long term, GMT would be made available to buyers at prices slightly greater than those for normal MST and lower than for SRT.

Other costs included miscellaneous expenses (repairs and maintenance, etc.) and rent for cages. Gross income, or sales, represent the value of the production based on the prevailing market price of tilapia in the locality. Net return is the residual difference between the gross income and the total production cost.

Since the production trials varied across farms and to some extent within farms, the calculation for costs and returns was standardized for comparison purposes. This was done by determining the daily costs and returns per m^2 (m^3 for cage culture) for the entire culture period of the different production system trials. Comparisons were then made among GMT, SRT and MST within each production system. Detailed costs and returns for ponds, cages and other systems are presented in Annex 4, Tables 4, 5 and 6 respectively. The pooled percentage difference (i.e. the net returns were first summed) in net returns between culture of GMT and MST or SRT are shown in Table 9. This method of calculation avoids bias caused by very large differences in some trials as seen in Tables Table 5 to Table 8.

Table 9 Percentage increase in net returns of producing GMT compared to SRT and MST under different culture systems.

Culture System	No. of Farms	% Increase
Fishpond (monoculture)		
GMT vs. SRT	6	112.06
GMT vs. MST	1	2,500.00
GMT vs. control	7	116.35
Cages		
GMT vs. SRT	1	13.55
GMT vs. MST	5	259.03
GMT vs. control	6	117.45
Tanks		
GMT vs. SRT	3	93.63
GMT vs. MST	1	136.54
GMT vs. control	4	124.77
Rice-fish		
GMT vs. MST	1	566.66
Fishpond (polyculture)		
GMT vs. MST	1	42.13

(Control is MST + SRT combined)

The analysis shows that the culture of GMT is considerably more profitable compared to that of MST or SRT. For monoculture in fishponds, the net returns for GMT more than doubled the net returns obtained from SRT. Pooled comparison between GMT and control (SRT and MST) gave a 116% increase in net income for GMT. Comparisons across the other culture systems likewise shows the superior profitability of the GMT. The average net return increases across the three main environments are very consistent, ranging from 116 to 125%. This enables us to conclude, with some confidence, that on average, farmers should be double their net returns by switching from their existing fish, to culturing GMT. This increase in net returns is a direct consequence of increased yield and thus higher sales, with negligible differences in production costs. It can be seen from tables 5-8 in Annex 4, that fingerling cost represents a small proportion of production costs, so it is likely that even if GMT were to be sold at a higher price, this would have a limited impact upon increases in net returns.

Technology transfer to Thailand

The rationale behind this component of the project was to investigate possible means by which the YY male technology, if proven successful in the Philippines, could be transferred to other countries. Any actual attempt to transfer technology would need to be considered on a case by case basis with attention being paid to quarantine, biodiversity conservation, strain characterisation and other related issues. Thailand was chosen as a suitable test case as there have been many previous transfers of tilapia germplasm between the two countries and many common problems are faced by their respective tilapia culture industries. It was considered that there are ultimately four options for disseminating the technology to Thailand:

- Direct transfer of the technology in the Egypt-Swansea strain: This could be achieved simply by transferring YY males, YY females and normal females (or the XX Δ♂ broodstock to produce them) to Thailand. GMT producing broodstock could then be generated from these transferred fish.
- Indirect transfer through crossbreeding: This could be achieved by crossing YY males from the Egypt-Swansea strain, transferred from the Philippines, to females of the Thai strain ("Egypt-AIT" or "Chitralada") to produce an inter-strain hybrid GMT.
- Indirect transfer through crossbreeding and backcrossing: YY males of the Egypt-Swansea strain would be transferred to Thailand and crossed to normal females and later to progeny tested Δ♀ of the Thai strain. A breeding programme for the production of YY males would then proceed, with backcrossing to the Thai strain or hybrids for each generation, gradually increasing the contribution of the local strain.
- Development of the technology anew in the Egypt-AIT strain: The breeding programme for YY male production (as outlined in the introduction) would be performed entirely within the local strain.

Clearly it was not feasible to pursue all these options in the time allotted in this project but it was hoped that significant progress could be made, enabling informed decisions regarding appropriate methodologies for technology transfer. To this end collaboration were established with two research groups based in Thailand: (i) The Agriculture & Food Engineering Program of the Asian Institute of Technology (AIT) and (ii) The National Aquaculture Genetics Research Institute (NAGRI) of the Thai Dept. of Fisheries. A number of manipulated fish were sent from the Philippines to Thailand in January 1993 and their quarantine was completed by mid-February. All possible genotypes were represented in progenies from XY x YY (control and feminised) and XX x XX (control and masculinised) crosses, as summarised in Table 10. These fish were transported as juveniles and were divided up equally between the NAGRI and AIT, for growing and progeny testing. Two previously identified, sexually mature, YY males were also transferred to AIT, one of which died shortly afterwards.

Table 10 Summary of types of fish transferred to Thailand in January 1993.

Parent Fish (CLSU) Female	Male	Treat-ment	Size	Destination	Expected outcome
Δ XY	YY	None	Fry	AIT & NAGRI	XY & YY ♂♂
Δ XY	YY	DES	Fry	AIT & NAGRI	XY & YY Δ♀♀
XX	Δ XX	None	Fry	AIT & NAGRI	Normal XX ♀♀
XX	Δ XX	MT	Fry	AIT & NAGRI	XX Δ♂♂
XY	YY	Tested	Adult♂	AIT	YY male bd'stock

There was slightly different emphasis on the research planned with the two collaborating institutions. Emphasis at AIT was placed on evaluating the feasibility of indirect transfers through hybridization, and the development of the technology anew in the Thai strain. At NAGRI emphasis was placed on direct transfer for the production of GMT within the Egypt-Swansea strain and it was also planned to conduct some comparative growth trials of GMT, SRT and MST in Thai environments.

Direct transfer

This was the simplest method of technology transfer, simply involving the progeny testing and further breeding of the fish transferred from the Philippines. Males and females from the Δ♀XY x ♂YY cross were on-grown at both AIT and NAGRI and progeny tested using the introduced normal females and Δ♂ XX genotypes of the same strain.

The results from the progeny testing of these YY males and females were in accordance with those observed in the Philippines, as reported in the final report of R.4803. YY genotypes were present in expected proportions and produced high proportions of males ranging from 74.0 to 100.0% male, with a mean of 94.9% for YY males and 97.7% for YY females.

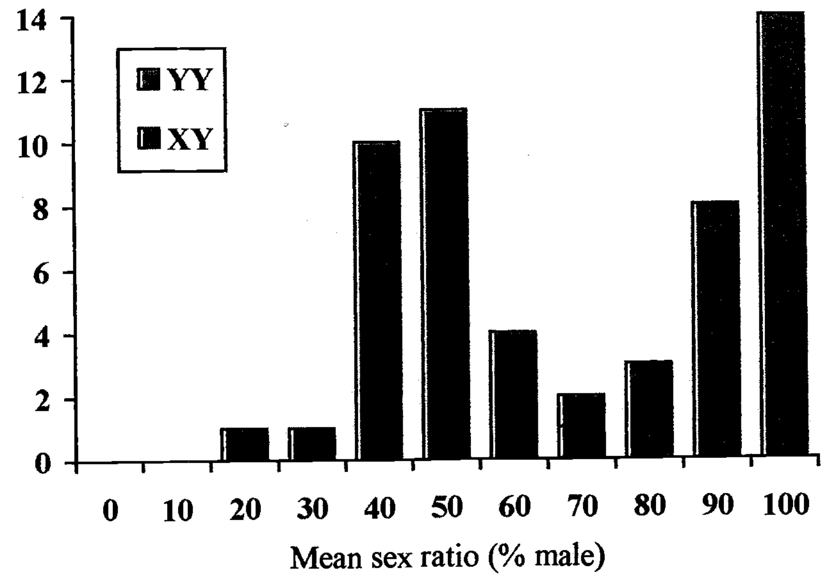
A total of nine YY x YY matings were made at AIT and NAGRI, with some of the YY progeny being feminized to produce further YY females. There were some mortalities of YY genotypes toward to end of the project. However, sufficient remained to form the next generation of YY males and thus YY production could be rapidly scaled up if desired.

This study demonstrated that the technology could be relatively easily transferred directly from one country to another and the time required to scale up to large scale production of GMT would depend on the number and type of fish initially transferred. In the case of this transfer, with the exception of one fish, the YY-genotypes transferred required progeny testing. This was due to the limited number of YY genotypes available in the Philippines at the beginning of the project. With the present availability of both male and female YY-genotypes, it would be possible to directly transfer the technology very rapidly.

Table 11 Summary of progeny testing for potential YY males (crossed to normal females) and YY females (crossed to XX Δ♂♂) in normal and feminized progeny of XY x YY crosses, transferred from the Philippines.

Summary Parameter	Males	Females
Number of potential YY genotypes tested	37	17
Number of progeny tested	2,617	928
Number of genotypes classed as XY (%)	20 (54.0)	8 (47.1)
Number of males not classified (%)	0	0
Number of genotypes classed as YY (%)	17 (46.0)	9 (52.9)
Expected number of YY genotypes (50.0%)	18.5	8.5
χ^2 for observed *vs.* expected no. of YY genotypes	0.243	0.029
Mean of sex ratios from XY genotypes (±SD.)	50.1 ± 8.1	52.9 ± 9.9
Mean of sex ratios from YY genotypes (±SD.)	94.9 ± 7.1	97.7 ± 3.9

Figure 6 Histogram showing family sex ratio distribution from the progeny testing of potential YY genotypes (males and feminized females) from XY x YY crosses, with XX genotypes (females and masculinised males).



YY males and estrogen treated delta females could be transferred together with XX females and androgen treated delta males. Small scale production of GMT could then commence within six months of the transfer and large scale production six months later, following mass production of broodstock.

The desirability of direct transfer would thus depend on time pressures and the production performance of introduced GMT producing strains, relative to local strains. In the context of Thailand some growth trials were performed as described on page 41.

Indirect transfer through crossbreeding

At AIT a number of crosses were made between the introduced YY males of the Egypt-Swansea strain and females of the Egypt-AIT strain, representing the simplest form of indirect transfer. Of ten matings set up (using the one surviving YY male transferred from the Philippines) seven spawnings were obtained. This work was repeated in the Philippines as part an M.Sc. project conducted under the auspices of the Project. The results form these crosses, which were similar, are shown in Table 12. Sex ratios were more variable, in some cases as low as 53%, and overall, lower than those observed in crosses within strain (Egypt-Swansea).

These results reflect differences in the sex determining mechanisms between the strains, possibly through the expression of autosomal sex modifying genes.

Table 12 Summary of sex ratios obtained from crosses of know YY males of the Egypt-Swansea strain, with normal females from the Egypt-AIT strain.

Item	At AIT	At CLSU
No. of fish tested	7	33
No. of fingerlings sexed	664	1,827
Sex ratio range (%♂)	53.3-100	54.8-100
Mean sex ratio (%♂)	88.8	92.7

These sex ratios are somewhat below the arbitrary 95% male limit which is commonly regarded as a useful critical limit, below which the benefits of sex control protocols are seriously restricted due to the likelihood of significant recruitment occurring. However, it is possible that under culture, the females among the hybrid GMT would be late maturing and not produce significant numbers of recruits, as has been observed in pure strain GMT populations. This would need to be tested under pond culture as this information was not revealed by the cage trials that were conducted at AIT (see page 41). Thus some doubts remain over the value of indirect transfer through the production of F_1 GMT hybrids.

To evaluate this further, the Egypt-AIT females that produced the highest sex ratios in the initial crosses with YY males ($\geq$ 96% male) were selected for further mating. These were mated with sex reversed XX males of the same strain (see page 38) to develop selected female lines of the Egypt-AIT strain which may produce higher sex ratios in GMT produced in crosses with the YY males of the Egypt-Swansea strain.

Indirect transfer through crossbreeding and backcrossing

A detailed breeding programme was devised whereby YY males could be produced, originating from crosses of YY male from the Egypt-Swansea strain to Δ♀♀ (XY) of the Egypt-AIT strain. This breeding programme had several initial stages which are described below:

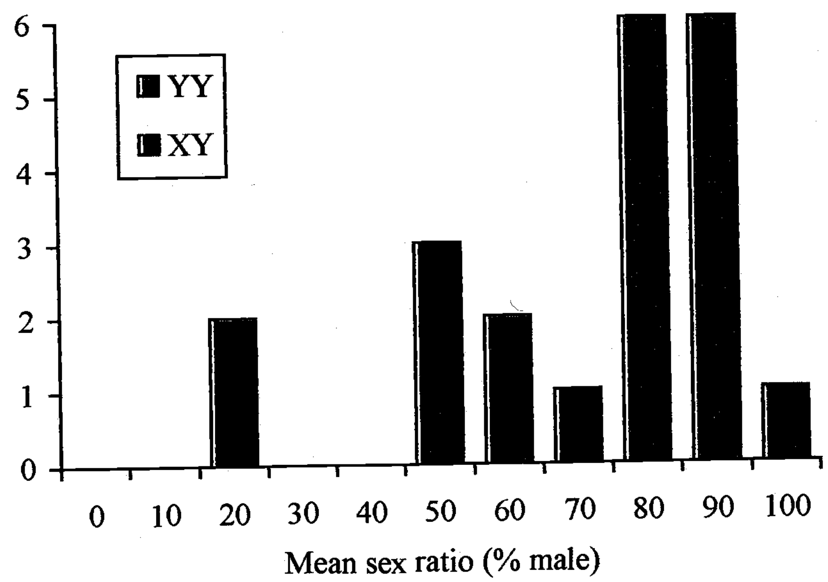
- Production of Δ♀♀ in the Egypt-AIT strain: DES treatments were applied to two normal crosses within this strain. Ten females resulting from the DES treatment (from the first cross, those from the second were still being on-grown at the end of the project) were progeny tested. These females were tested in crosses with XX Δ♂ of the same strain. Three produced sex ratios not significantly different to the 1:1 sex ratios expected from Δ♀♀ (XY).

- Production of hybrid YY males and females: The previously identified Δ♀♀ of the Egypt-AIT strain were crossed with YY males of the Egypt-Swansea strain, a total of six families being obtained. Upon completion of yolk sac absorption, each family was divided into two batches, with one being subjected to DES treatment. Due to low survival rates both control and DES treated progeny respectively, were pooled. Sexing of samples of these pooled fish revealed an expectedly high percentage of males in the untreated control (97.2% male; n=140) but a rather low rate of feminization with the DES treated fish having a sex ratio of 63.9% male (n=122)..

- Progeny testing for hybrid YY genotypes: A total of 21 hybrid males were progeny tested in crosses with normal XX females of the Egypt-AIT strain. Using the statistical criteria developed for the identification of YY males (sex ratios significantly skewed to male; $P<0.001$), 14 of these 21 males were classed as YY. This proportion of YY males (66.7%) is higher than the expected (50.0%) although not significantly so. The sex ratios from these hybrid YY males ranged from 70.0 to 100.0% male with a mean of 88.23, similar to that observed in the F_1 hybrid crosses. Four of these crosses produced in excess of 96.0% male progeny and the YY male parents of these have been retained for future YY male production. By the end of the project six spawnings had been obtained from the DES treated hybrid females. It is hoped that a number of hybrid YY females will be identified and F_2 hybrid YY males produced by crossing these to the F_1 hybrid YY males. GMT and subsequent generations of YY males could then be produced by crossing F_2 YY males respectively to normal and sex reversed females of the Egypt-AIT strain, thereby reducing the relative genetic contribution from the Egypt-Swansea strain.

- In terms of sex ratio produced, it was not possible to determine whether this form of indirect transfer would be more beneficial than the simpler method of indirect transfer described previously. However, this method, incorporating back-crossing, maybe more appropriate if the Thai strain exhibits superior culture performance to the Egypt-Swansea or the F_1 hybrid between the two strains, as the GMT ultimately produced would primarily posses the properties of the Thai strain.

Figure 7 Histogram showing family sex ratio distribution from the progeny testing of potential hybrid YY males with XX females on the Egypt-AIT strain.



Development of the YY male technology in Thai strains

The development of Δ♀♀ (XY) males described in the previous section (page 39) is also part of the initial phase of development of the YY male technology anew in the Egypt-AIT strain. The next stage of this process is to cross the identified Δ♀♀ (XY) with normal males of the Egypt-AIT strain, and to progeny test the resulting males to identify YY males. Two such crosses have been made and the progeny were being on-grown for testing at the end of the project.

Clearly this method of technology transfer is the most time consuming and would only be appropriate if it was deemed undesirable to transfer new tilapia germplasm into the country or if the local strain exhibited significantly superior growth performance to that of the introduced GMT producing strain or its hybrid with the local strain.

In anticipation of the eventual need for large numbers of normal Egypt-AIT strain females to be used in crosses with YY males of the Egypt-AIT, hybrid or Egypt-Swansea strains, a total of six, androgen treated Δ♂♂ were identified. These were identified by the high proportion of females (81-100%) in their progeny when crossed with normal females. A number of XX x XX crosses were then made and the progeny androgen treated to provide future broodstock for large scale production of females of the Thai strain.

Comparative growth performance trials of monosex populations of the Egypt-Swansea and Thai strains and their hybrids

At AIT a comparative growth evaluation of pure and hybrid populations of GMT and SRT was conducted between August 1994 and March 95, in replicated cages in an 800m^2 fertilized earthen pond. The treatments compared are shown in Table 13.

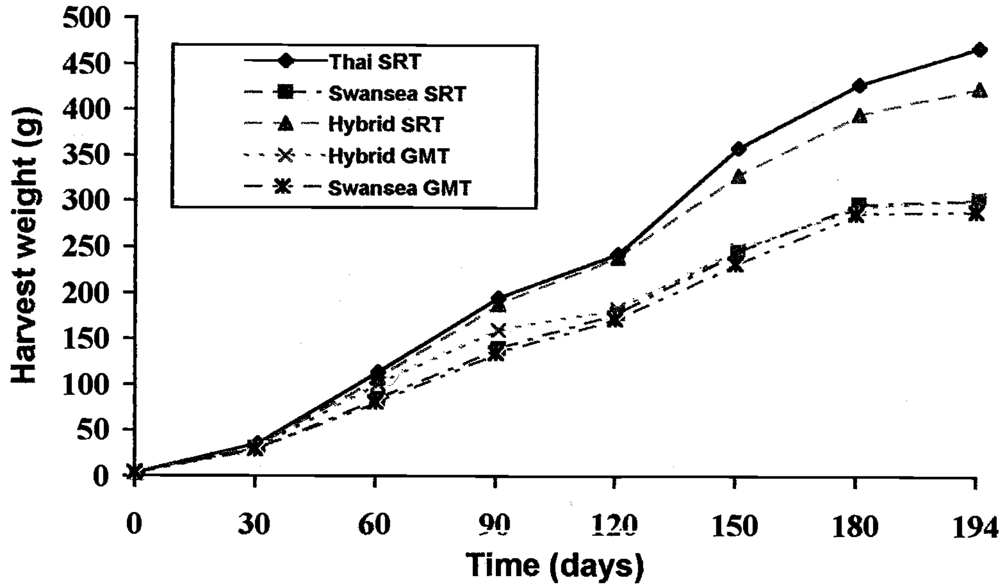
Table 13 Experimental design for growth rate experiment conducted in replicated cages (3 per treatment) in a pond at AIT.

Cross	Treatment	Progeny type	Sex ratio (%♂ at harvest)
XY (T) x XX (T)	MT	SRT - Thai	98.6
XY (S) x XX (T)	MT	SRT - Hybrid	100.0
XY (S) x XX (S)	MT	SRT - Swansea	99.4
YY (S) x XX (S)	---	GMT - Swansea	96.2
YY (S) x XX (T)	---	GMT - Hybrid	82.6

S - Egypt-Swansea strain; T - Egypt-AIT strain

There was no significant difference in growth performances among these genotypes during the first two months. However, in the two following months, differences developed with two distinct classes of performance. After the fifth month of culture, the growth performance of these genotypes could be catalogued into two homogeneous groups and there were highly significant differences in harvest weight between the two groups ($P<0.001$). Thai SRT and the hybrid SRT clearly out-performed the other three treatments together. There were no significant differences between the hybrid GMT, and Egypt-Swansea GMT or SRT. Similarly, the difference between Thai SRT and the hybrid SRT was not significant. This result is difficult to interpret as the division of the treatment into the two performance classes cannot be attributed solely to treatment nor to strain effects.

Figure 8. Results from relative growth performance trials of SRT and GMT of Egypt-Swansea, Egypt-AIT and their hybrids, grown in 2 m² cages in a pond at AIT (50 fish per cage with 3 replicates).



It can be noted from Table 13 that the sex ratio of the hybrid GMT was lower than that of the other groups, possibly because of mis-idenfication of one of the YY males used to produce these, or simply that one of the crosses did produce a low sex ratio of GMT. This low sex ratio could have accounted for the poorer performance of this treatment compared to the hybrid SRT. It seems reasonable to assume that if the sex ratio of the hybrid GMT had been higher (>95%) then its performance would have been comparable with the hybrid SRT (all previous within strain trials of GMT and SRT have shown the performance of GMT to be the same or better than SRT). In this case it would be evident that the Thai strain (Egypt-AIT) and its hybrid with the Egypt-Swansea strain, exhibited superior growth performance to the Egypt-Swansea strain under the conditions used in this trial. Both these strains originate in Egypt but have very different histories of domestication. The Thai strain has been produced at AIT for more than ten generations. It is thus quite possible that the population may have undergone a degree of local adaptation to the prevailing environmental and culture conditions at AIT. This is supported by the evidence from CLSU which indicates that the growth performance of these two strains does not differ under the prevailing conditions there.

The results from this trial have considerable implications for the choice of method for transferring the technology to Thailand. Given the importance of these trials it was decided to repeat the comparisons and a new experiment was set up in the last month of the project. This second trial incorporates mixed sex controls with the treatments shown in Table 14.

Table 14 Experimental design for second growth rate experiment to be conducted in replicated cages (3 per treatment) in a pond at AIT.

Cross	Treatment	Progeny type
XY (T) x XX (T)	MT	SRT - Thai
XY (S) x XX (T)	MT	SRT - Hybrid
XY (S) x XX (S)	---	MST - Swansea
XY (T) x XX (T)	---	MST - Thai
YY (S) x XX (S)	---	GMT - Swansea
YY (S) x XX (T)	---	GMT - Hybrid
YY (TxS) x XX (T)	---	GMT - Hybrid

S - Egypt-Swansea strain; T - Egypt-AIT strain; TxS - Hybrid YY male

A second, unreplicated, growth trial was conducted by NAGRI at a Dept. of Fisheries station in Nakhon Phanom, using only fish of the Egypt Swansea strain. At the time of writing the harvest data for this trial, in which MST, SRT and GMT were stocked in identical ponds, was not available. The latest available data from the final sampling prior to harvest is shown in Table 15.

Table 15 Mean weight (from a sample of 30 fish) and sex of fish from single ponds at Nakhon Phanom station, stocked with MST, SRT and GMT of the Egypt-Swansea strain.

Treatment	Mean Weight (g ± s.e.)	Recruit Biomass (g)	Sex ratio (% male)
MST	211.8 (± 7.9)	112	67.6
SRT	288.0 (± 10.9)	5	96.4
GMT	260.9 (± 5.5.)	0	100.0

As this is sampling data, and survival could not be determined, it is not known whether growth would have been influenced by density effects brought about through differential mortality. Absolute yield cannot be determined and we do not know whether the apparent larger size of SRT would result in a higher yield. Other than the larger size of the SRT, the results appear to reflect those obtained in the Philippines, with GMT having higher sex ratios than both MST and SRT. In addition, it appears that size variability is lower in the GMT and recruits apparently absent, reflecting the absence of females in the population. A second growth trial with each treatment replicated in three ponds has begun at a Dept. of Fisheries station in Surin, with fingerlings being stocked in March 1995.

Personnel and Training

Although not one of the original primary objectives of the project, local personnel development has come to be regarded as a vital component of our programme. Continued support from ODA, directly or through the Technical Cooperation Training Programme (TCTP) of the British Council, has enabled us to continue to develop and train staff. In addition, progress made by the project, and the outstanding contribution that the collaboration has made to the facilities and activities of the Freshwater Aquaculture Center of CLSU, were recognised by the Philippine Government in the form of partnership funding for a Fish Genetics and Biotechnology Program (FGBP) at CLSU.

Training, and staff development

The following training was enabled under the auspices of the project:

- Ruben Sevilleja, CLSU: Project related British Council (TCTP) funding was secured for Ruben Sevilleja, director of FAC, to conduct his Ph.D. research on the socio-economic impact of the YY male technology with the Centre for Development Studies (CDS) at UWS. This programme commenced in January 1993 and forms a major component of the project following on from the one described in this report.
- Emmanuel Vera Cruz, CLSU: . Mr. Vera Cruz, CLSU's local counterpart to the Project, travelled to Thailand to attend an "Intensive production of Nile tilapia" short course at AIT in June/July 1993. He stayed on for a further three months at AIT attending courses and participating in research activities including those at AIT's outreach station in the Northeast of Thailand. Mr. Vera Cruz's travel and training was funded by the British Council's TCTP, as "project related'.
- Jose Abucay, Philippine Project staff: Mr. Abucay, project research assistant in charge of on-station research, travelled to Thailand, attending the same "Intensive production of Nile tilapia" short course at AIT in June/July 1993.

- Lilia Dahilig, CLSU Project Staff: Ms. Dahilig, project research assistant in charge of on-farm research, spent 3 weeks at AIT in November\December 1994. Here she received training in mass fry production techniques and she also visited AIT's outreach project in Udorn Thani where she received training in farmer participatory research.

- Pham Anh Tuan, AIT: Mr. Tuan was a Vietnamese scientist working as a research assistant at AIT with responsibilities for the AIT based component of this project. Mr. Tuan travelled to CLSU at the end of June 1993 to receive a comprehensive one week theoretical and practical training on the YY male technology. Miss Urai, a research assistant from NAGRI was unable to attend the training in this quarter due to financial constraints on behalf of the AADCP which had kindly agreed to fund her.

In addition to programmes of formal tertiary education and training, project scientists were supported in their participation in workshops and national and international symposia:

- Leah Dahilig and Graham Mair, travelled to Iloilo City in November to attend the "Third National Symposium Workshop on Tilapia Farming" where they presented an overview of the project and the results from the growth trials of GMT and participated in the working groups on research needs, extension and marketing.

- Graham Mair, Eric Roderick (UWS), Emmanuel Vera Cruz, , Leah Dahilig, Jose Abucay (CLSU), Pham Anh Tuan (AIT\Vietnam) and Nuanmanee Pongthana (NAGRI) attended the second "AADCP International Workshop on Genetics in Aquaculture and Fisheries Management", held in Phuket, Thailand, November 6-11, 1994. Project related papers and posters were presented on techniques for feminization and fish marking, and results from work on genotype environment interactions, on-farm growth performance of GMT, characterisation of YY males and methods for technology transfer.

Institutionalization

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Institutionalization

A major advance made toward the end of the project was the approval of the proposal by our Principal Collaborator (FAC, CLSU) for institutionalization of project activities. This proposal, formulated between FAC and UCS, and conceived under a previous ODA funded project (R.4803), has the rationale of ensuring the continuation of project research, development and extension under the auspices of a University programme (the Fish Genetics and Biotechnology Program). The Philippine Government approved a budget for the fiscal year 1995 (Jan. - Dec.) of 1,100,000 pesos, for this programme. This incorporated a budget of P760,000 for salaries and the remainder for maintenance and operating expenses. The majority of the staff trained under this and previous ODA funded projects will be taken up under this Institutionalization programme and may ultimately become permanent staff of the University, if the budget is approved year-on-year.

This institutionalized programme was initiated on March 16, 1995 with a total of 12 staff (including four previously hired by this project) being incorporated into this programme.

This development is potentially of critical importance as it should help to ensure the long term stability and further progress of the advances made under this and other ODA funded projects. A detailed outline of the structure of this institutionalized program is provided in the annex to the final report on R.4803.

The Second National Workshop

Following on from the "First National Workshop on the YY male technology for the production of genetically male tilapia (GMT)" in Sept. 1993 (held under R.4803) a second meeting was held under this project. This took the form of a two day workshop for fisheries scientists from State Colleges and Universities (SCUs) and was held in early October, 1994. Details of the Project's progress and objectives were presented on the first day. The second day was taken up with discussions of the facilities available at each of the concerned institutions (there were 21 delegates representing 14 SCUs). Further discussion concentrated on the prospects for and potential structure of a National Network of hatcheries producing and disseminating GMT. The majority of delegates were enthusiastic to proceed with this network with several committing to fund the establishment of their own hatcheries. Others will clearly need to obtain financial support to develop or upgrade their hatchery facilities. Distribution of GMT producing broodstock could be divided into three or four phases, depending on the need for facilities and financial resources of the SCUs. The first phase of distribution of GMT producing broodstock to existing hatcheries could commence in mid 1995. Subsequent phases of distribution could only occur with the provision of financial support for hatchery development, possible utilizing income generated from fish sales. Dissemination of fish through a network of SCUs has a number of considerable advantages. The SCUs are regionally dispersed, some being in areas in which tilapia culture is only recently developing, and could act as catalysts for the expansion of tilapia production in these areas. This network could also enable the SCUs to generate income so that their production can become self sustaining and possibly even generate profits to support research activities in aquaculture. The proposed structure for a network of GMT producers was provided in an Annex to the Final Report of R.4803.

Further regional dispersal of GMT could be achieved with the assistance of NGOs. This would concentrate on specific groups of farmers in specific locations. However the scale of production that could be achieved through SCU hatcheries and NGOs would initially be quite limited and larger scale dissemination of GMT should be achieved through private sector hatcheries located in the major tilapia growing areas.

Implications and Future Priorities

This project succeeded in meeting most of its objectives and made very significant progress in the evalution of the potential gains to be had from the dissemination of the YY male technology and on developing and evaluating methods for transfer of this technology between countries.

The potential benefits of the YY male technology

The results from the on-farm trials were exceptionally promising in relation to the potential for application of this technology to increase tilapia production in extensive and semi-intensive culture of tilapia in the tropics. Culture of GMT resulted in significant improvements in all measured harvest characteristics which in turn lead to very significant increases in net returns for the farmers. Whilst it is not possible to separate the effects of strain (all GMT were of the Egypt-Swansea strain, compared to controls of various Philippine strains) from that of the sex ratio, it seems likely that the latter was the major effect (based from the results obtained from within strain trials conducted under R.4803). It is perhaps surprising that the GMT of the Egypt-Swansea strain did perform so consistently better than the MST and SRT of Philippine strains. The Egypt-Swansea strain is considered to be inbred due to its passage through several genetic bottlenecks and it has been shown to exhibit low levels of allozyme variation. The results from these trials indicate that there is little evidence for any inbreeding depression in this strain.

There was no evidence that the benefits of culture of GMT were specific to any environment or culture practice. It is thus reasonable to assume that any Philippine farmer switching from his presently cultured fish, to GMT, would expect to observe an improvement in yield and profitability.

The relative performance differences observed in these trials were very evident and it is considered that there is no pressing need to conduct further trials simply to validate the performance of GMT, compared to presently used farm strains. It would be of greater interest to conduct further comparisons of the performance of GMT *vs.* well sex reversed SRT and also to compare the relative benefits of culturing GMT in cages and in ponds. Justification for setting up such trials would be difficult given the costs and physical and human resources that would be required and the high failure rate that would be likely. It is hoped in the long term that further information would be gained through the monitoring of performance of fish disseminated to farmers.

There can be little doubt remaining, given the potential benefits of GMT culture, that dissemination of the YY male technology in the Philippines should now begin, as recommended by the participants of the first and second seminar workshops on the YY male technology. Initially this should be through the distribution of GMT to tilapia growers. The work on intensive hatchery techniques, broodstock development and broodstock generation, conducted under this project and under R.4803, have provided the capacity for medium scale production of GMT at FAC\CLSU. The Project achieved its objective of scaling up GMT production to a level equivalent to more than one million fry per month and this can be expanded much further with the production of larger numbers of broodfish and the construction of a large scale hatchery (which was virtually completed by the end of project). Indeed the first distribution of GMT to Philippine tilapia farmers took place in the last month of the project.

Important issues to be considered for the future (many of which are incorporated in a follow up project - R.6070A) are:

- The fry production performance of the Egypt-Swansea strain compared to commonly cultured Philippines strains, and the relative reproductive performance of YY males *vs.* normal males.
- Mechanisms for dissemination of the GMT and the YY male broodstock to ensure take up by all sectors of the industry with emphasis on small scale farmers (see concept paper on a GMT fry production network as annex to final report on R.4803). Critical issues will be the choice of cooperative organisations, the structure of dissemination networks, pricing structures, and accreditation, monitoring, and data gathering procedures.
- The sustainability of research, development and extension work through income generation, financial stability and job security for staff training under

the project. This has been achieved to a degree with institutionalization but this needs to be taken further.

- The potential socio-economic impacts of the introduction of the YY male technology and of better performing all-male tilapia for culture. This has begun to be addressed through the Ph.D. research of Ruben Sevilleja but needs to be further developed.

Methods for technology transfer

Although firm conclusions cannot be made, the research results obtained through the work of the Thai collaborators, do provide useful indicators for planning for technology transfer to Thailand. Given the apparent poor performance of the Egypt-Swansea strain in the growth trials at AIT, it is unlikely that direct transfer will prove the most successful method of transfer. Such an approach would not utilise the apparent superior growth performance of the Egypt-AIT strain. If it can be shown in subsequent growth trials that the performance of the hybrid GMT is equivalent to, or superior to, that of the Egypt-AIT SRT, then an indirect approach may be the best means of transfer. Whether this would be best achieved through simple crossbreeding or the more complex method of backcrossing would depend on the actual relative performance of the hybrid *vs.* the pure Egypt-AIT strain and also the sex ratios obtained from these different types of crosses. If the pure Egypt-AIT strain does consistently demonstrate superior growth performance under Thai conditions then the best option may be to develop the technology anew in this strain. The success of this approach would however depend upon the sex ratios of GMT that could be obtained from YY males of this strain.

Thus it is apparent that some further data on relative growth performance and inter- and intra-strain sex determination is required before firm decisions could be made on the optimal method for technology transfer to Thailand. Similar information would be required to make informed decisions regarding transfer of the YY male technology to other countries.

Issues relating to conservation of possibly unique tilapia germplasm are not of major concern in the transfer of the Egypt-Swansea strain from the Philippines to

Thailand as *O. niloticus* is an introduced species in both countries. In fact the two strains of major concern both have Egypt as a common country of origin.

Conservation of genetic diversity and environmental concerns over the introduction of GMT might be a issue of greater importance if it was desirable to introduce the YY male technology either directly or indirectly to other countries. This would be a very major concern if the technology were to be transferred to countries or regions with endemic populations of *O. niloticus*. With the possible exception of Egypt (from where the Egypt-Swansea strain originates) it would be unwise to consider direct or indirect methods of transfer to such countries.

Publications

The following publications (in alphabetical not chronological order) came to press during this project as a result of research conducted fully or partly under the project:

Abella, T.A. (1994) Genetical studies on the inheritance of selected traits in *Oreochromis niloticus* and red tilapia. Ph.D. thesis, University of Wales. 149p.

Mair, G.C., Abucay, J.S., Capili, J.B., Dahilig, L.R., Sevilleja, R.C., Beardmore, J.A. and Skibinski, D.O.F. (1994) The development of YY male technology for production of monosex tilapia in the Philippines. Tilapia Farming: Genetic Improvement and Advances in Culture Technology. Proc. Third National Symposium and Workshop on Tilapia Farming, University of the Philippines, Visayas, Iloilo, Philippines, Nov. 25-27, 1993. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna. PCAMRD Book Series 18: 27-35.*

Mair, G.C., Estabillo, C.C., Sevilleja, R.C. and Recometa, R.D. (1993). Small-scale fry production systems for Nile tilapia, *Oreochromis niloticus* (L.). Aquaculture and Fisheries Management, 24: 231-237.*

Mair, G.C., Vera Cruz, E.M., Garcia, M.A.R., Capili, J.B., Abucay, J.S., Abella, T.A., Beardmore, J.A. and Skibinski, D.O.F. (1993). Genetic manipulations - prospects for improvement of tilapia for culture in the Philippines. In J.J. Dodson, K. Soewardi, V.P.E. Phang, G.L. Enriques, U. Na-Nakorn and S. Sukimin (eds.) Fish Genetics and its Application to Aquaculture and Fishery Management. BIOTROP Spec. Publ. 52: 55-57.*

Pongsri, C. (1994) Genetic approaches to improvement of tilapia culture in Thailand. Ph.D. thesis, University of Wales. 229p.

In addition the following publications are in press or have been submitted for publication:

Mair, G.C., Abucay, J.S., Dahilig, L.R., Capili, J.B., Roderick, E.E., Skibinski, D.O.F., and Beardmore, J.A. (submitted) The YY-Male Technology for the production of monosex male tilapia, *Oreochromis niloticus* (L.) - Research progress update. Proceedings of the Second AADCP International Workshop on Genetics in Aquaculture and Fisheries Management, Phuket, Thailand, Nov. 7-11, 1994.

Mair, G.C., Estabillo, C.C. and Dahilig, L.R. (in press) Artificial incubation for intensive fry production of Nile tilapia, *Oreochromis. niloticus* (L.) Proceedings of the National Seminar-Workshop on Breeding and Seed Production of Important Cultured Finfishes in the Philippines, SEAFDEC, Tigbauan, Iloilo, Philippines, May 4-5, 1993.

Roderick, E.E., Garcia-Abiado, M.A.R., and Mair, G.C. (submitted) Fish tagging and marking methods for genetic programmes in aquaculture. Proceedings of the Second AADCP International Workshop on Genetics in Aquaculture and Fisheries Management, Phuket, Thailand, Nov. 7-11, 1994.

Tuan, P.A., Abucay, J.S., Little, D.C. and Mair, G.C. (submitted) Preliminary investigation in to the feasibility of transfer of the YY male technology to the Thai Chitralada strain of *Oreochromis niloticus* L. Proceedings of the Second AADCP International Workshop on Genetics in Aquaculture and Fisheries Management, Phuket, Thailand, Nov. 7-11, 1994.

* - *Joint publication between ODA projects, also included in final report or R.4803.*

The project has received further publicity during this quarter, most notably with a 10 minute segment on an agricultural documentary programme, Agrilink. This included footage and interviews at the project's research site and at the harvest of fish from a farmer cooperator. A very favourable image of the technology was presented.

ACKNOWLEDGMENTS

The very significant progress made under this project could not have been achieved without the very considerable efforts of all concerned project staff in the Philippines, Thailand and the U.K. Particular gratitude is due to Lilia Dahilig, Joe Abucay and the GMIT staff in the Philippines, Pham Anh Tuan and Urai in Thailand. I am sure they in turn would credit the dedicated effort of the other research and field staff of their respective projects. Immense gratitude is due also to the collaborating institutes. Of particular note are the contributions of President Battad, Ruben Sevilleja, Tereso Abella and Arsenia Cagauan at CLSU, most especially for their unstinting support of our aims and for their efforts in promoting Institutionalization. The assistance of Ruben Reyes and other BFAR staff in helping make contact with farmers is appreciated. The coordinating roles of David Little (AIT) and Nuanmanee Pongthana (NAGRI) have been instrumental in the progress made in Thailand.

Annexes

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Tables summarising culture conditions, production and economic data from on-farm trials.

ANNEX 1

Glossary Of Acronyms

BFAR	Philippines Bureau of Fisheries and Aquatic Resources
CDS	Centre for Development Studies (UWS)
CLSU	Central Luzon State University
DES	Diethylstilboestrol - female hormone
FAC	Freshwater Aquaculture Center (CLSU)
GIFT	ICLARM's Genetic Improvement of Farmed Tilapia (Project)
GMT	Genetically Male Tilapia (derived from YY males)
GMIT	Genetic Manipulations for Improved Tilapia (Project)
ICLARM	International Center for Living Aquatic Resources Management
MST	Mixed-Sex Tilapia (from crossing of normal broodstock)
MT	17-α methyltestosterone - androgenic hormone
NAGRI	National Aquaculture Genetics Research Institute (Thailand)
NFFTRC	National Freshwater Fisheries Training and Research Center (of BFAR)
ODA	Overseas Development Administration
SRT	Sex Reversed Tilapia (treated with MT)
TAD	Technology Adaptation and Development (Project)
TCTP	Technical Cooperation Training Programme of British Council, Manila
UWS	University of Wales, Swansea

ANNEX 2

Table showing source of all strains of *O. niloticus* used in the project

Project nomenclature	Common name	Origin	Year collected	Obtained From	Year transferred to the Philippines	Year obtained by the project	Reference
Egypt - AIT	Thailand	Egypt	1960	Asian Institute of Technology (AIT), Thailand	1991	1991	Basiao and Taniguchi, (1984)
Egypt - BFAR	Thailand	Egypt	1960	NFFTRC/BFAR, Nueva Ecija, Philippines	1987	1989	Chotiyarnwong (1971) Eknath et al. (1993)
Egypt - ICLARM	Egypt	Creeks near Port Said, Egypt	1988	GIFT Project, ICLARM, Philippines	1988	1989	Eknath et al. (1993)
Egypt - Stirling	Stirling	L. Manzala, Egypt	1979	Institute of Aquaculture, University of Stirling, Scotland	1993	1993	Hussain (1992)
Egypt - Swansea	Swansea	L. Manzala, Egypt	1979	University College of Swansea, Wales	1989	1989	Hussain (1992) and Mair et al. (1991)
Ghana - ICLARM	Ghana	Volta River System, Ghana	1988	GIFT Project, ICLARM, Philippines	1988	1989	Eknath et al. (1993)
Ghana - BFAR	Israel	Ghana	1974 (?)	NFFTRC/BFAR Nueva Ecija, Philippines	1979	1989	Pullin and Capili (1988)
Kenya - Baobab	Baobab	Baobab Farm, Kenya	1988	University College of Swansea, Wales	1993	1993	E. Abban and S. Baer (pers. comm.)
Kenya - Baringo *O. n. baringoensis*	Baringo	L. Baringo, Kenya	1975, 1982	University College of Swansea, Wales	1990	1993	E. Abban and S. Baer (pers. comm.)
Kenya - Turkana *O. n. vulcani*	Vulcani	Crater Lake A, Kenya	1991	University College of Swansea, Wales	1993	1993	J. Buya (pers. comm.)
Red Tilapia (*O. niloticus* type)	Red Tilapia	Kirmay, Abra, Philippines	1977	FAC, CLSU, Nueva Ecija Philippines	1979	1989	Capili (1981)

ANNEX 3

FARMFACT FILES FOR COMPLETED ON-FARM TRIALS

Pond Farmers

Abes-1, General Tinio, Nueva Ecija, Central Luzon

Mendoza, Longos, Calumpit, Bulacan, Central Luzon

Feliciano, Ayala, Magalang, Pampanga, Central Luzon

Pamintuan, San Roque, Pampanga, Central Luzon

Pangasinan State University, Binmally, Panagasinan, Central Luzon

Cruz, Pinahan, General Natividad, Nueva Ecija, Central Luzon

CRSP, CLSU, Muñoz, Nueva Ecija, Central Luzon

Cage Farmers

Bondad, Banyaga, Agoncillo, Batangas, Southern Luzon

CAMPCI, Canili, Ma. Aurora, Quezon, Western Luzon

MFI Project, Lemery, Batangas Southern Luzon

SMP-PMPC, Aya Dam, Pantabangan Reservoir, Nueva Ecija, Central Luzon

Sibul Cage Farming Project, Sibul,Talavera, Neuva Ecija, Central Luzon

Obungen, Magat Reservoir, Ramon, Isabela, Northern Luzon

Tank Farmers

MFI Farming Project, Jala-jala, Rizal, Southern Luzon

Puyat, Sta. Rosa, Nueva Ecija, Central Luzon

San Miguel Feeds Inc., Calatrava, Negros Occidental

Other Farmers

DA-IRRI Rice-Fish Project, Guimba, Nueva Ecija, Central Luzon

CRSP, CLSU, Muñoz, Nueva Ecija, Central Luzon

FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**Abes Farm - First Trial**
Location:	Aberra Compound, Gen. Tinio, Nueva Ecija
Contact Person:	Mr. Carlos Abes
Culture System:	Earthen Ponds
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	1,536.5
Stocking number\density:	4,500 @ 2.93 pcs. per m^2
Stocking date:	April 07, 1994
Harvest date:	August 30, 1994
Culture Period:	145 days
GMT Origin:	From production of February 16, 1994
Control Origin:	Mixed sex tilapia- Farmers fish
Growth Data File Name:	ABES-1.WQ1
Economic Data File Name:	ABES-1.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	2.74	4.94	-45.92	
SD	0.37	0.54		
Mean Weight (g)	0.97	4.83	-79.92	
SD	0.35	1.51		
Sex Ratio (%)	100			

Management System Operated:

Water Source:	shallow well
Feeding:	Last month of the culture period (twice a day)
Fertilization	as needed
Water Quality	Observed abundant natural foods in ponds
Harvest Method	seining and draining by pump

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	2,712.48	3,342.13	-18.84	
Survival (%)	60.27	74.27	-18.84	
Sex ratio (% male)	99.00	46.80	+111.54	
Mean SL (cm)	13.38	13.90	-3.74	
Mean Weight (g)	190.64	113.70	+67.67	
CV of weight (%)	17.69	22.98	-23.02	
FCR	n/a	n/a		
Biomass (kg)	517.0	380.0	+36.05	
Total Biomass (kg)	517.0	380.0	+36.05	

Remarks and Observations:

Partial harvesting was employed due to the irregular demand in the market. The harvesting lasted for one week and these caused the incomplete collection of recruit data. The farmer observed a lot of recruitment in MST pond while almost nothing in GMT pond, however it was very hard to quantify.

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)	Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
			GMT	**MST**	**GMT**	**MST**
Fingerlings	2.93	0.30/pc	0.8786	0.8786	0.0061	0.0061
Feeds	0.11	12.07/kg	1.2765	1.2765	0.0088	0.0088
Fertilizer	n/a	n/a	n\a	n\a	n\a	n\a
Fuel/Electricity						
SAE oil	0.004	47.00/li	0.1880	0.1880	0.0013	0.0013
Diesel	0.084	9.80/li	0.8198	0.8198	0.0056	0.0056
Miscellaneous			5.8611	5.8611	0.0404	0.0404
Labor cost			0.9419	0.9419	0.0065	0.0065
Total Cost			9.9659	9.9659	0.0687	0.0687
Food Fish Sale	0.34	54.00/kg	18.1699	n/a	0.1253	n/a
Food Fish Sale	0..25	54.00/kg	n/a	13.3550	n/a	0.0921
Total Sales			18.1699	13.3550	0.1253	0.0921
Net Return			8.2039	3.3891	0.0566	0.0234

Summary:

A successful trial revealing the advantage of culturing all-male population.

ABES FARM- First Trial

Location:	Gen Tinio, Nueva Ecija
Culture unit:	Earthen ponds
Size of culture unit:	1,536.5 sq.m.
Stocking Density:	4,500 per pond
Stocking Date:	April 07, 1994
Harvest Date:	August 30, 1994
Days of culture:	145 days

ECONOMIC DATA

COST OF PRODUCTION		
Inputs		**Amount**
Stocks	4,500 fingerlings at P 0.30/pc	1,350.0
Feeds	6.5 bags of commercial feeds at 301.75/bag	1,961.40
Fuel	Oil	286.86
	Diesel	1259.61
Salaries and Wages		1,447.22
Miscellaneous		9,005.58
Total Production Cost		**15,312.67**

* the same production cost for GMT and SRT

SRT		GMT	
Sales	Amount (P)	Sales	Amount (P)
380 kgs at P 54.00	20,520.00	517 kgs at P 54.00	27,918.00
Production cost	15,312.67	Production Cost	15,312.67
Net Profit	**5,207.33**	Net Profit	**12,605.33**

FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**Bondad Cage Project**
Location:	Banyaga, Agoncillo, Batangas
Contact Person:	Mr. Manny Bondad
Culture System:	Taal Lake
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	100 m^2 or 400 m^3 (10 x 10 x 4 m)
Stocking number\density:	4,500 @ 45/m^2 or @ 11.25/m^3
Stocking date:	April 16, 1993
Harvest date:	July 15, 1994
Culture Period:	90 days
GMT Origin:	From production of February 16, 1993
Control Origin:	Produced by the Meralco foundation (SRT fish)
Growth Data File Name:	Bondad.WQ1
Economic Data File Name:	Bondad.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	5.20	4.90	+6.12	ns
SD	0.70	0.65		
Mean Weight (g)	8.71	6.05	+43.96	ns
SD	3.39	1.84		
Sex Ratio (%Male)	99.00	98.33	+0.70	

Management System Operated:

Water Source:	Lake water/spring
Feeding:	Three times a day with Shuen shen commercial feeds
Fertilization	none
Water Quality	Observed some high primary productivity
Harvest Method	Concentrating the fish on one corner of the cage then scooping
Remarks:	Harvested

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	3699	3590	+3.0	
Survival (%)	82.2	79.8	+3.0	
Sex ratio (% male)	99.0	98.3	+0.7	
Mean SL (cm)	16.4	14.7	+11.6	
Mean Weight (g)	215.3	163.4	+31.8	
Coefficient of variation	28.5	32.7	-12.8	
FCR	1.9	2.0	-5.1	
Total Biomass (kg)	665.0	632.0	+5.2	

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)	Unit Price	Amount (P/m^3/cropping)		Amount (P/m^3/day)	
			GMT	**SRT**	**GMT**	**SRT**
Fingerlings	11.25	0.50/pc	5.6250	5.6250	0.0625	0.0625
Feeds	3.12	11.00/kg	33.0000	33.0000	0.3667	0.3667
Cage Rent			0.7500	0.7500	0.0083	0.0083
Miscellaneous			1.2500	1.2500	0.0139	0.0139
Labor cost			6.0000	6.0000	0.0667	0.0667
Total Cost			**46.6250**	**46.6250**	**0.5181**	**0.5181**
Food Fish Sale	1.66	48.00/kg	79.8000	n/a	0.8867	n/a
Food Fish Sale	1.58	48.00/kg	n/a	75.8400	n/a	0.8427
Total Sales			**79.8000**	**75.8400**	**0.8867**	**0.8427**
Net Return			**33.1750**	**29.2150**	**0.3686**	**0.3246**

Remarks and Observations:

Growth performance trial of GMT in Taal lake was conducted to observe and verify the performance of GMT in the lake environment. An intensive culture system was employed using a stocking density of 45 fingerlings/sq.m with complete feeding of commercially formulated feeds. The stocking density commonly used in the area which ranges from 75-100 fingerlings sq.m. was not followed in the trial due to some unavoidable problem during the nursing of the fingerlings. We delivered 10,000 fingerlings for a 10m x 10m cage but more than half of the fish escaped in the nursing hapa due to strong winds.

After three months culture period the trial was a success. Although yield difference of GMT and SRT was not so great, still GMT had better yield compared to SRT fish produced by MFI. These might be due to the high percentage of male in both populations (GMT-99% and SRT-98.33).

FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**Bondad Cage Project**
Location:	Banyaga, Agoncillo, Batangas
Contact Person:	Mr. Manny Bondad
Culture System:	Taal Lake
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	100 m^2 or 400 m^3 (10 x 10 x 4 m)
Stocking number\density:	4,500 @ 45/m^2 or @ 11.25/m^3
Stocking date:	April 16, 1993
Harvest date:	July 15, 1994
Culture Period:	90 days
GMT Origin:	From production of February 16, 1993
Control Origin:	Produced by the Meralco foundation (SRT fish)
Growth Data File Name:	Bondad.WQ1
Economic Data File Name:	Bondad.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	5.20	4.90	+6.12	ns
SD	0.70	0.65		
Mean Weight (g)	8.71	6.05	+43.96	ns
SD	3.39	1.84		
Sex Ratio (%Male)	99.00	98.33	+0.70	

Management System Operated:

Water Source:	Lake water/spring
Feeding:	Three times a day with Shuen shen commercial feeds
Fertilization	none
Water Quality	Observed some high primary productivity
Harvest Method	Concentrating the fish on one corner of the cage then scooping
Remarks:	Harvested

Tilapia cage culture in Taal lake was really a very profitable bussiness thats why the cage industry is expanding very fast. In some way, the government agencies involved in lake protection and prevention should be aware of these for immediate protection. We should not allow having another unproductive lake in the future like Sampaloc and Laguna lake.

Summary:

The three months intensive cage culture trial of GMT was a success.

BONDAD CAGE PROJECT

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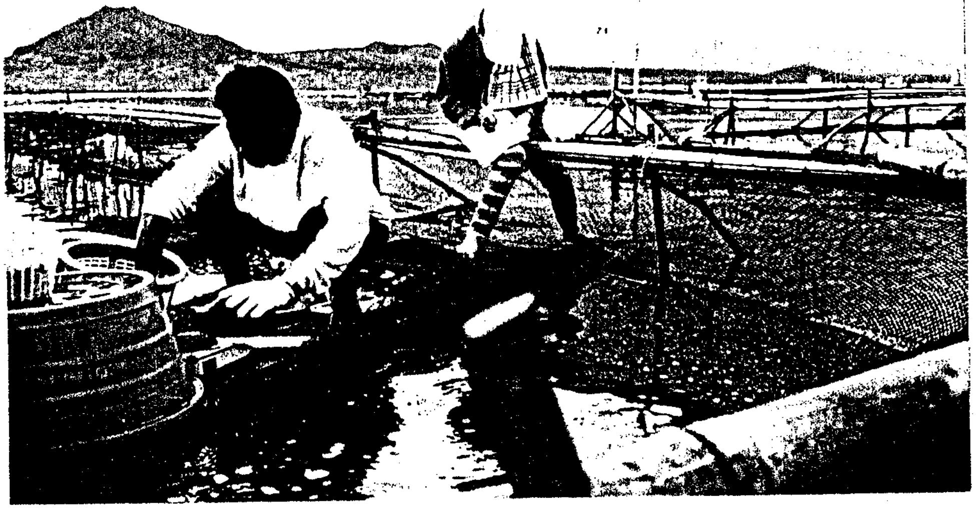
Location:	Banyaga, Agoncillo, Batangas
Culture unit:	Lake cages
Size of culture unit:	100 sq.m.
Stocking Density:	4,500 per cage
Stocking Date:	April 16, 1994
Harvest Date:	July 15, 1994
Culture Period	90 days

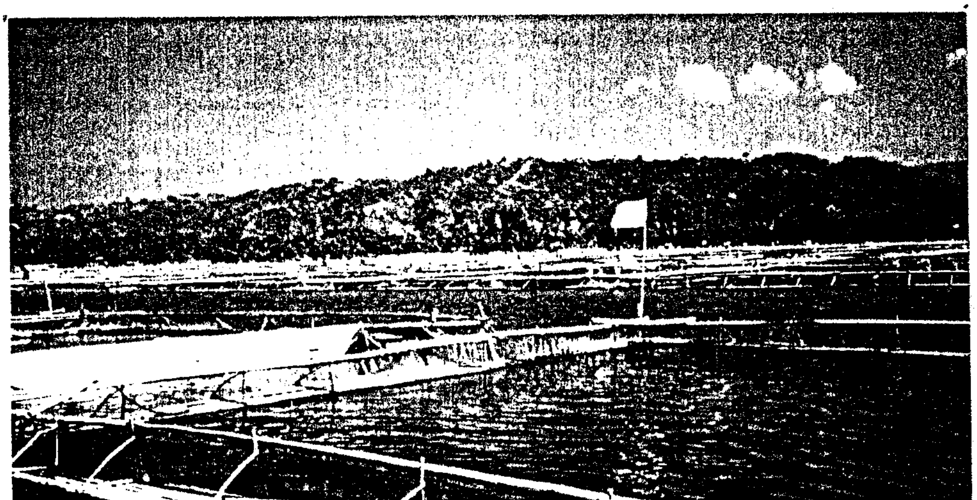
ECONOMIC DATA

COST OF PRODUCTION		
Inputs		**Amount**
Stocks	4,500 pcs. at P 0.50/pc	2,250.00
Feeds	1,250 kg at P11.00/kg	13,200.00
Cage rent	P 300.00/cage	300.00
Miscellanous		500.00
Labor cost		2,400.00
Total Production Cost		**18,650.00**

*Both for GMT and SRT

	GMT (P)		**SRT (P)**
Sales		Sales	
665 kgs at P 48.00/kg	31,920.00	632 kgs at P 48.00/kg	30,336.00
Production Cost	18,650.00	Production Cost	18,650.00
Net Profit	**13,270.00**	**Net Profit**	**11,686.00**





FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**CAMPCI Cooperative Farm**
Location:	Canili, Ma. Aurora
Contact Person:	Mr. Bernardo Paleng
Culture System:	Lake cage
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	56 m^2 or 168 m^3 (7m x 8m x 3m)
Stocking number\density:	1,000 @ 17.86/ m^2 or @ 5.95/ m^3
Stocking date:	Novemberr 20, 1993
Tentative Harvest date:	May 24, 1994
Culture Period:	170 days
GMT Origin:	From production of July 29, 1993
Control Origin:	Israel strain produced by GMIT-TAD Project From production of July 20, 1993
Growth Data File Name:	CAMPCI.WQ1
Economic Data File Name:	CAMPCI.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	3.79	3.85	-1.55	ns
SD	0.67	0.50		
Mean Weight (g)	2.09	2.17	-3.69	ns
SD	1.31	0.90		
Sex Ratio (%Male)	96	30		

Management System Operated:

Water Source:	Pantabangan Reservoir
Feeding:	Twice (2) a day with B-meg commercial feeds
Fertilization	none
Water Quality	Low primary productivity
Harvest Method	Concentrating the fish on one corner of the cage then scooping

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	587.0	689.98	-15.0	
Survival (%)	58.7	69.0	-15.0	
Sex ratio (% male)	97.0	45.0	+116.0	
Mean SL (cm)	15.6	13.8	+13.0	
Mean Weight (g)	153.3	108.0	+42.0	
Coefficient of Variation (%)	40.7	45.8	-11.0	
FRC	1.39	1.68	-17.26	
Biomass (kg)	90.0	74.5	+21.0	
Total Biomass (kg)	90.0	74.5	+21.0	

Remarks and Observations:

No major problem exist during the entire culture period. However, the low survival rate in GMT and MST were due to the poor water quality of the lake. The farmer stated that they observed dead fish early in the morning. This was after a very calm day when water in the lake was so still. This might be due to the very minimal oxygen diffusion from the atmosphere to the water which results to insufficient amount of dissolve oxygen on the deeper portion of the lake. The farmer also stated that this is the first time (our trial) they were able to harvest 70 to 90 kg of fish/cage because they often got only around 40-50 kg of fish/cage.

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)		Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
	GMT	MST		GMT	MST	GMT	MST
Fingerlings	5.95	5.95	0.25/pc	1.4881	1.4881	0.0088	0.0088
Feeds	0.74	0.74	13.20/kg	9.8214	9.8214	0.0578	0.0578
Cage Rent				1.7857	1.7857	0.0105	0.0105
Miscellaneous				n\a	n\a	n\a	n\a
Labor cost				1.6964	1.6964	0.0100	0.0100
Total Cost				**14.7917**	**14.7917**	**0.0870**	**0.0870**
Food Fish Sale	0.49	0.39	45.00/kg	21.9642	17.5446	0.1292	0.1032
Food Fish Sale	0.048	0.054	30.00/kg	1.4286	1.6071	0.0084	0.0094
Total Sales				23.3929	**19.1518**	**0.1376**	**0.1137**
Net Return				**8.6012**	**4.3601**	**0.0506**	**0.0256**

Summary:

A very useful trial in cage environment.

CAMPCI CAGE PROJECT

Location:	Pantabangan Dam, Canili, Ma. Aurora
Culture unit:	Lake cages
Size of culture unit:	96 sq.m.
Stocking Density:	1,000 per cage
Stocking Date:	November 20, 1993
Harvest Date:	May 24, 1994
Days of culture:	170 days

ECONOMIC DATA

COST OF PRODUCTION	
Inputs	**Amount**
Stocks 1000 fingerlings at P 0.25/pc	250.00
Feeds 5 bags of commercial feeds at P 330.00/bag (25kg/bag)	1,650.00
Cage Rent	300.00
Labor	285.00
Total Production Cost	**2,485.00**

* the same production cost for GMT and MST

	GMT		MST
Sales 82.0 kg at P 45.00/kg 8.0 kg at P 30.00/kg	3,690.00 240.00	Sales 65.5 kg at P 45.00/kg 9.0 kg at P 30.00/kg	4,485.50 270.00
Production Cost	2,485.00	Production Cost	2,485.00
Net Profit	**1,445.00**	**Net Profit**	**732.50**

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	587.0	689.98	-15.0	
Survival (%)	58.7	69.0	-15.0	
Sex ratio (% male)	97.0	45.0	+116.0	
Mean SL (cm)	15.6	13.8	+13.0	
Mean Weight (g)	153.3	108.0	+42.0	
Coefficient of Variation (%)	40.7	45.8	-11.0	
FRC	1.39	1.68	-17.26	
Biomass (kg)	90.0	74.5	+21.0	
Total Biomass (kg)	90.0	74.5	+21.0	

Remarks and Observations:

No major problem exist during the entire culture period. However, the low survival rate in GMT and MST were due to the poor water quality of the lake. The farmer stated that they observed dead fish early in the morning. This was after a very calm day when water in the lake was so still. This might be due to the very minimal oxygen diffusion from the atmosphere to the water which results to insufficient amount of dissolve oxygen on the deeper portion of the lake. The farmer also stated that this is the first time (our trial) they were able to harvest 70 to 90 kg of fish/cage because they often got only around 40-50 kg of fish/cage.

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)		Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
	GMT	**MST**		**GMT**	**MST**	**GMT**	**MST**
Fingerlings	5.95	5.95	0.25/pc	1.4881	1.4881	0.0088	0.0088
Feeds	0.74	0.74	13.20/kg	9.8214	9.8214	0.0578	0.0578
Cage Rent				1.7857	1.7857	0.0105	0.0105
Miscellaneous				n\a	n\a	n\a	n\a
Labor cost				1.6964	1.6964	0.0100	0.0100
Total Cost				**14.7917**	**14.7917**	**0.0870**	**0.0870**
Food Fish Sale	0.49	0.39	45.00/kg	21.9642	17.5446	0.1292	0.1032
Food Fish Sale	0.048	0.054	30.00/kg	1.4286	1.6071	0.0084	0.0094
Total Sales				23.3929	**19.1518**	**0.1376**	**0.1137**
Net Return				8.6012	4.3601	**0.0506**	**0.0256**

Summary:

A very useful trial in cage environment.

CAMPCI CAGE PROJECT

Location: Pantabangan Dam, Canili, Ma. Aurora
Culture unit: Lake cages
Size of culture unit: 96 sq.m.
Stocking Density: 1,000 per cage
Stocking Date: November 20, 1993
Harvest Date: May 24, 1994
Days of culture: 170 days

ECONOMIC DATA

COST OF PRODUCTION	
Inputs	**Amount**
Stocks 1000 fingerlings at P 0.25/pc	250.00
Feeds 5 bags of commercial feeds at P 330.00/bag (25kg/bag)	1,650.00
Cage Rent	300.00
Labor	285.00
Total Production Cost	**2,485.00**

* the same production cost for GMT and MST

	GMT		MST
Sales 82.0 kg at P 45.00/kg 8.0 kg at P 30.00/kg	3,690.00 240.00	Sales 65.5 kg at P 45.00/kg 9.0 kg at P 30.00/kg	4,485.50 270.00
Production Cost	2,485.00	Production Cost	2,485.00
Net Profit	**1,445.00**	**Net Profit**	**732.50**

FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**CRSP Project**
Location:	FAC, CLSU, Nueva Ecija
Contact Person:	Prof. Eduardo Lopez
Culture System:	Pond
Number of Culture Units:	Nine (9); 3 for GMT and 6 for Control
Size of Culture Units (m^2):	500
Stocking number\density:	1,000 @ 2 per sq.m.
Stocking date:	May 31, 1994
Harvest date:	October 30, 1994
Culture Period:	135 days
GMT Origin:	From production of March 2, 1994
Control Origin:	Sex reversed tilapia produced in FAC using FAC and Thailand strain
Growth Data File Name:	CRSP.WQ1
Economic Data File Name:	CRSP.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	5.87	6.07	-03.29	ns
SD	1.37	0.78		
Mean Weight (g)	4.00	3.97	+00.75	ns
SD	2.60	1.45		
Sex Ratio (%Male)	100			

Management System Operated:

Water Source:	Deep-well and irrigation water
Feeding:	noneI
Fertilization	weekly fertilization at the rate of 3.25 kg of 16-20-0 and 2.15 kgs of urea for every 500 sq.m. pond.
Water Quality	Observed some primary productivity
Harvest Method	Seining and draining with pump

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	871.00	739.00	+17.86	
Survival (%)	87.10	73.90	+17.86	
Sex ratio (% male)	-	-		
Mean SL (cm)	17.89	16.90	+5.86	
Mean Weight (g)	122.39	101.13	+21.02	
Coefficient of variation	26.29	19.77	+32.98	
Total Biomass (kg)	98.81	69.34	+42.50	

Remarks and Observations:

Growth performance of the Genetically Male Tilapia (GMT) population and commercially available tilapia population was assessed using the simplest form of production system, that of only pond fertilization. Ponds were fertilized with only inorganic fertilizer at the rate of 28 kg of N per week. With the same culture management and production inputs, growth and survival (equivalent to yield) of GMT population was observed to be better than the control population. Sex ratio and recruits in each population were not properly gathered.

The trial was accomplished in collaboration with the CRSP Project of CLSU.

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)	Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
			GMT	**MST**	**GMT**	**MST**
Fingerlings	2.00	0.30/pc	0.6000	0.6000	0.0044	0.0044
Feeds	n/a	n/a	n\a	n\a	n\a	n\a
Fertilizer						
Urea	0.08	6.00/kg	0.4644	0.4644	0.0034	0.0034
16-20-0	0.12	6.00/kg	0.7020	0.7020	0.0052	0.0052
Fuel/Electricity	n/a	n/a	n\a	n\a	n\a	n\a
Miscellaneous			1.0000	1.0000	0.0074	0.0074
Labor cost			0.9188	0.9188	0.0068	0.0068
Total Cost			**3.6852**	**3.6852**	**0.0273**	**0.0273**
Food Fish Sale	0.20	45.00/kg	8.8920	n/a	0.0659	n/a
Food Fish Sale	0.14	45.00/kg	n/a	6.2370	n/a	0.0462
Total Sales			**8.8920**	**6.2370**	**0.0659**	**0.0462**
Net Return			**5.2068**	**2.5518**	**0.0386**	**0.0189**

Summary:

A successful pond trial using the simplest form of production system. This revealed that even in the low-input production system, GMT population proves its advantage.

CRSP PROJECT

Location:	FAC, CLSU, Nueva Ecija
Culture unit:	Earthen ponds
Size of culture unit:	500 sq.m.
Stocking Density:	1,000 per pond
Stocking Date:	May 31, 1994
Days of culture:	135 days

ECONOMIC DATA

COST OF PRODUCTION	
Inputs	**Amount**
Stocks 1,000 fingerlings at P 0.30/pc	300.00
Fertilizer 38.7 kgs of UREA at P 6.00/kg 58.5 kgs of 16-20-0 at P 6.00/kg	583.20
Miscellaneous	500.00
Labor cost	459.40
Total Production Cost	**1,842.60**

* the same production cost for GMT and SRT

G M T		S R T	
	Amount (P)		Amount(P)
Sales 98.8 kg at P 45.00	4,446.00	Sales 69.3 kgs at P 45.00	3,118.5.00
Production cost	1,842.60	Production Cost	1,842.60
Net Profit	**2,603.40**	Net Profit	**1,275.90**

Summary:

A successful pond trial using the simplest form of production system. This revealed that even in the low-input production system, GMT population proves its advantage.

CRSP PROJECT

Location:	FAC, CLSU, Nueva Ecija
Culture unit:	Earthen ponds
Size of culture unit:	500 sq.m.
Stocking Density:	1,000 per pond
Stocking Date:	May 31, 1994
Days of culture:	135 days

ECONOMIC DATA

COST OF PRODUCTION	
Inputs	**Amount**
Stocks 1,000 fingerlings at P 0.30/pc	300.00
Fertilizer 38.7 kgs of UREA at P 6.00/kg 58.5 kgs of 16-20-0 at P 6.00/kg	583.20
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Net Profit	**2,603.40**	Net Profit	**1,275.90**

FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**CRSP Project - Second Trial**
Location:	FAC, CLSU, Nueva Ecija
Contact Person:	Prof. Eduardo Lopez
Culture System:	Pond - Polyculture of tilapia and catfish
Number of Culture Units:	Five (5); 2 for GMT and 3 for Control
Size of Culture Units (m^2):	500
Stocking number\density:	1,000 @ 2 per sq.m. (tilapia)
Stocking number\density:	150 @ 0.3 per sq.m. (catfish)
Stocking date:	November 22, 1994
Harvest date:	April 17, 1995
Culture Period:	135 days
GMT Origin:	From production of September 7, 1994
Control Origin:	BFAR-Thailand strain
Growth Data File Name:	CRSP-2.WQ1
Economic Data File Name:	CRSP-2.EDF

Stocking Data:

	GMT		Control		% GMT difference		significance
	tilapia	catfish	tilapia	catfish	tilapia	catfish	
Mean SL (cm)	5.56		4.98		+11.65		
SD	0.60		0.72				
Mean Weight (g)	3.12		2.42		+28.92		
SD	1.15		0.92				
%Male	100.00						

Management System Operated:

Water Source:	Deep-well and irrigation water
Feeding:	noneI
Fertilization	weekly fertilization at the rate of 3.25 kg of 16-20-0 and 2.15 kgs of urea for every 500 sq.m. pond.
Water Quality	Observed some primary productivity
Harvest Method	Seining and draining with pump

Harvest Data:

	GMT		Control		% GMT difference		significance
	tilapia	catfish	tilapia	catfish	tilapia	catfish	
Number harvested	963.00	106.00	736.00	117.00	+30.84	-9.40	
Survival (%)	96.30	70.67	73.60	78.00	+30.84	-9.40	
Sex ratio (% male)	-	-	-	-			
Mean SL (cm)	18.28	-	18.45	-	-17.00		
Mean Weight (g)	119.29	150.90	121.66	101.70	-1.95	+48.37	
CV of weight (%)	13.61	-	20.28	-	-32.88		
Biomass (kg)	102.50	16.00	83.00	11.90	+23.49	+34.45	
Recruit biomass(kg)	2.25		2.80		-19.64		
Total Biomass (kg)	104.75	16.00	85.8	11.90	+22.08	+34.45	

Economic data (in Philippine Pesos):

Items	Qty (unit/m²)		Unit Price	Amount (P/m²/cropping)		Amount (P/m²/day)	
	GMT	MST		GMT	MST	GMT	MST
Fingerlings				0.9000	0.9000	0.0067	0.0067
Tilapia	2.00	2.00	0.30/pc	0.6000	0.6000	0.0044	0.0044
Catfish	0.30	0.30	3.00/pc	0.3000	0.0022	0.3000	0.0022
Feeds	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Fertilizer				1.1664	1.1664	0.0086	0.0086
Urea	0.08	0.08	6.00/kg	0.4644	.04644	0.0034	0.0034
16-20-0	0.12	0.12	6.00/kg	0.7020	0.7020	0.0052	0.0052
Fuel/Electricity				n\a	n\a	n\a	n\a
Miscellaneous				0.6000	0.6000	0.0044	0.0044
Labor cost				0.9188	0.9188	0.0068	0.0068
Total Cost				3.5852	3.5852	**0.0266**	**0.0266**
Food Fish Sale							
Tilapia	0.205	0.166	45.00/kg	9.2254	7.4700	0.0683	0.0553
Catfish	0.032	0.024	60.00/kg	1.9200	1.4280	0.0142	0.0106
Total Sales				11.1415	8.8980	**0.0826**	**0.0659**
Net Return				7.5598	5.3128	**0.0560**	**0.0394**

Remarks and Observations:

The only polyculture trial conducted. A combination of tilapia and catfish were used with the intention of using catfish as predator to control the tilapia population. Results revealed that GMT with or without catfish obviously had better yield than the mixed sex tilapia with catfish. The presence of the catfish in the MST population did not give much significant contribution on the yield of tilapia. This could possibly be due to the low stocking density of catfish such that they could not fully control the reproduction of tilapia in ponds. The observed recruitment in the GMT population were unaccountable since sex ratio data were not available. The farmer was not sure whether there was flooding or overflowing that happened during the culture period.

<u>Summary</u>:

A successful polyculture trial of tilapia and catfish.

CRSP PROJECT- Second Trial
Polyculture of Tilapia and Catfish

Location:	FAC, CLSU, Nueva Ecija
Culture unit:	Earthen ponds
Size of culture unit:	500 sq.m.
Stocking Density:	1,000 (tilapia) and 150 (catfish)
Stocking Date:	November 22, 1994
Harvest Date:	April 17, 1995
Days of culture:	135 days

ECONOMIC DATA

COST OF PRODUCTION	
Inputs	**Amount**
Stocks 1,000 tilapia fingerlings at P 0.30/pc	300.00
150 catfish fingerlings at P 1.00	150.00
Fertilizer 38.7 kgs of UREA at P 6.00/kg 58.5 kgs of 16-20-0 at P 6.00/kg	583.20
Miscellaneous	300.00
Labor cost	459.40
Total Production Cost	**1,792.60**

* the same production cost for GMT and MST

G M T		MST	
	Amount (P)		Amount(P)
Tilapia sales 102.50 kg at P 45.00	4,612.50	Tilapia sales 83.00 kgs at P 45.00	3,735.00
Catfish sales 16.00 kgs at P 60.00	960.00	Catfish sales 11.90 kgs. at P 60.00	714.00
Production cost	1,792.60	Production Cost	1,792.60
Net Profit	**3,779.90**	Net Profit	**2,656.40**

FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FA RM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**Cruz FARM**
Location:	Pinahan, Gen. Natividad, Nueva Ecija
Contact Person:	Ms. Dory Cruz
Culture System:	Pond
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	1,700
Stocking number\density:	12,000 @ 7 per sq.m.
Stocking date:	August 20, 1993
Harvest date:	March 1, 1994
Culture Period:	192 days
GMT Origin:	From production of July 13, 1993
Control Origin:	Sex reversed tilapia produced by Robert So's farm
Growth Data File Name:	CRUZ.WQ1
Economic Data File Name:	CRUZ.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	2.58	2.16	+16.24	ns
SD	0.46	0.22		
Mean Weight (g)	0.66	0.41	+37.87	ns
SD	0.38	0.19		
Sex Ratio (%Male)	100			

Management System Operated:

Water Source:	Deep-well and irrigation water
Feeding:	Three (3) times a day with farmers formulated feeds and B-meg commercial feeds
Fertilization	as needed
Water Quality	Observed some primary productivity
Harvest Method	Seining and draining with pump

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	7,037	6,247	+12.6	
Survival (%)	59.0	52.0	+13.5	
Sex ratio (% male)	90.0	51.2	+75.8	
Mean SL (cm)	15.1	13.9	+8.6	
Mean Weight (g)	135.9	102.0	+33.2	
FCR	0.55	0.77	-28.6	
CV of weight (%)	21.4	25.2	-15.1	
Total Biomass (kg)	950.0	679.0	+39.9	

Remarks and Observations:

Staggered harvesting due to market demand made it impossible to quantify the number/amount of recruits produced in the SRT ponds. Recruits however were imediately thrown into ponds to serve as food for the african catfish.

The very low survival rate of the fish were possibly due to poor water management

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)	Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
			GMT	SRT	GMT	SRT
Fingerlings	7.00	0.35/pc	2.4706	2.4706	0.0129	0.0129
Feeds						
formulated	0.07	11.20/kg	0.8340	0.8340	0.0043	0.0043
Rice-bran	0.12	5.50/kg	0.6441	0.6441	0.0034	0.0034
commercial	0.12	11.24/kg	1.3224	1.3224	0.0069	0.0069
Fertilizer						
Urea	0.05	5.88/kg	0.2764	0.2764	0.0014	0.0014
16-20-0	0.02	8.00/kg	0.1882	0.1882	0.0010	0.0010
Manure	0.12	0.72/kg	0.0847	0.0847	0.0004	0.0004
Manure	0.88	0.80/kg	0.6941	0.6941	0.0036	0.0036
Fuel/Electricity	0.071	7.30/li	0.5153	0.5153	0.0027	0.0027
Miscellaneous	n\a	n\a	n\a	n\a	n\a	n\a
Labor cost			5.2941	5.2941	0.0276	0.0276
Total Cost			**12.3241**	**12.3241**	**0.0642**	**0.0642**
Food Fish Sale	0.56	50.00/kg	27.9412	14.8235	0.1455	0.0772
Food Fish Sale	0.10	35.00/kg	n/a	3.6029	n/a	0.0188
Total Sales			**27.9412**	**18.4265**	**0.1455**	**0.0960**
Net Return			**15.6171**	**6.1024**	**0.0813**	**0.0318**

Summary:

Despite the very low survival of fish in both ponds, we can still consider the trial a very useful one. This trial should be a comparison of GMT and mixed sex fish population because of the SRT's very low sex ratio.

CRUZ FARM

Location:	General Natividad, Nueva Ecija
Culture unit:	Earthen ponds
Size of culture unit:	1,700 sq.m.
Stocking Density:	12,000 per pond
Stocking Date:	August 20, 1993
Harvest Date:	February 28 to March 2
Days of culture:	192 days

ECONOMIC DATA

COST OF PRODUCTION		
	Inputs	**Amount**
Stocks	12,000 fingerlings at P 0.35/pc	4,200.00
Fertilizer	2 bags of UREA at P 235.00/bag (40kg.bag)	470.00
	1 bag of 16-20-0 at P 320.00/bag (40kg/bag)	320.00
	8 bags of chicken manure at P 18.00/bag (25kg/bag)	144.00
	59 bags of chicken manure at P 20.00/bag (25kg/bag)	1,180.00
Feeds	126.6 kgs formulated feeds (mixture of rice bran, fish meal-meat and bone, and corn meal) at P 11.20/kg	1,417.92
	199.1 kgs of Rice bran D-1 at P 5.50/kg	1,095.05
	8 bags of commercial feeds at P 281.00/kg (25kg/bag)	2,248.00
Fuel	120 liters of diesel for 6 month at P 7.30/li	876.00
Labor	P 9,000 for 6 months at P1,500/month	9,000.00
Total Production Cost		20,950.97

* the same production cost for GMT and SRT

S R T		G M T	
	Amount(P)		Amount(P)
Sales 504 kgs at P 50.00	25,200.00	Sales 950 kgs at P 50.00	47,500.00
175 kgs at P 35.00	6,125.00		
Production cost	20,950.97	Production Cost	20,950.97
Net Profit	**10,374.03**	Net Profit	**26,549.03**

FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**DA-IRRI Rice-fish Project**
Location:	Brgy. Triala, Guimba, Nueva Ecija
Contact Person:	Mr. Romeo Basa
Culture System:	Rice-fish
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	558 sq.m. (5% of the total land area)
Stocking number\density:	279 @ 0.5 per sq.m.
Stocking date:	December 23, 1993
Harvest date:	April 26, 1994
Culture Period:	124 days
GMT Origin:	From production of October 1993
Control Origin:	Produced by BFAR
Growth Data File Name:	DA-IRRI.WQ1
Economic Data File Name:	DA-IRRI.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	4.87	5.79	-0.16	ns
SD	0.43	0.67		
Mean Weight (g)	4.14	6.32	-2.18	ns
SD	1.02	2.12		
Sex Ratio (%Male)				

Management System Operated:

Water Source:	deep-well
Feeding:	Two to three times a week (feeding started one month after the fish were stocked in paddy trench)
Fertilization	Only rice were being fertilized
Water Quality	Observed low primary productivity
Harvest Method	seining and draining by pump

treatments. This could probably be the reason why the growth performance difference of SRT and MST was slight.

The foundation was convinced of the GMT's good performance and they expressed their willingness to be involved in the dissemination of the fish to the farmers in the future.

Summary:

Another successful verification of the GMT population's good performance.

Harvest Data:

	GMT	Control	% GMT difference	significance
Number harvested	195.0	172.0	13.4	
Survival (%)	69.9	61.6	13.5	
Sex ratio (% male)	93.3	47.1	98.1	
Mean SL (cm)	10.9	9.6	13.5	
Standard deviation (cm)	4.46	0.97		
Mean Weight (g)	49.3	33.6	46.7	
Standard deviation (g)	10.5	10.5		
Biomass (kg)	9.6	5.8	65.5	
Recruit Biomass (kg)	0.3	2.5	-88.0	
Total Biomass (kg)	9.9	8.3	19.3	

Remarks and Observations:

The short culture period of 129 days which was dependent on the culture days of rice gave us unmarketable size fish at harvest. This maybe due to stocking small size of fish (#17), shallow trench (18 inches depth) and the irregularity of supplemental feeding during the culture period.

It is recommended that much bigger fish should be stocked in rice-fish culture environment so that the fish can be reach marketable size at rice harvest time. Proper feeding technique should also be employed for better growth of fish.

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)	Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
			GMT	**MST**	**GMT**	**MST**
Fingerlings	0.50	0.20/pc	0.1075	0.1075	0.0009	0.0009
Feeds	0.0090	3.50/kg	0.0314	0.0314	0.0003	0.0003
Fertilizer	0.0045	3.60/kg	0.0161	0.0161	0.0001	0.0001
Fuel/Electricity	n/a	n/a	n\a	n\a	n\a	n\a
Miscellaneous			0.0269	0.0269	0.002	0.002
Labor cost			0.0896	0.0896	0.0007	0.0007
Total Cost			**0.2715**	**0.2715**	**0.0022**	**0.0022**
Food Fish Sale	0.0172	30.00/kg	0.5161	n/a	0.0042	n/a
Food Fish Sale	0.0104	30.00/kg	n/a	0.3118	n/a	0.0025
Total Sales			**0.5161**	**0.3118**	**0.0042**	**0.0025**
Net Return			**0.2446**	**0.0403**	**0.0020**	**0.0003**

Summary:

A useful rice-fish trial.

DA-IRRI RICE-FISH PROJECT

Location:	Brgy. Triala, Guimba, Nueva Ecija
Culture unit:	Rice-fish -trench
Size of culture unit:	558 sq.m.
Stocking Density:	0.5 per sq.m.
Stocking Date:	December 23, 1993
Harvest Date:	April 26, 1994
Days of Culture	124 days

ECONOMIC DATA

Inputs	Amount (P)
Stocks 300 fingerlings at P 0.20/pc	60.00
Feeds 5 kg of darak at P 3.50/kg	17.50
Fertilizer 2.5 kgs of sulfate fertilizer at P3.60/kg	9.00
Miscellaneous	15.00
Labor cost	50.00
Total Production Cost	**151.50**

* GMT and SRT

GMT		MST	
	Amount (P)		Amount (P)
Sales 9.6 kgs at P 30.00	288.00	Sales 5.8 kgs at P 40.00	174.00
Production cost	151.50	Production Cost	151.50
Net Profit	**136.50**	Net Profit	**22.50**

FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**Feliciano's Farm**
Location:	Ayala, Magalang Pampanga
Contact Person:	Mr. Waldo Feliciano
Culture System:	Ponds
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	1,610 (GMT) and 1,680 (SRT)
Stocking number\density:	7,000 and 7,200 @ 4.5 per sq.m.
Stocking date:	December 22, 1993
Tentative Harvest date:	April 08, 1994
Culture Period:	107 days for SRT and 121 days gor GMT
GMT Origin:	From production of November 4, 1993
Control Origin:	Sex reversed tilapia (Thailand strain) produced by Feliciano's Farm
Growth Data File Name:	FELICIAN.WQ1
Economic Data File Name:	FELICIAN.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	1.92	2.25	-14.66	ns
SD	0.29	0.25		
Mean Weight (g)	0.32	0.54	-40.24	ns
SD	0.18	0.18		
Sex Ratio (%Male)	98			

Management System Operated:

Water Source:	Own dammed reservoir-rainfed
Feeding:	Three (3) times a day with B-meg commercial feeds
Fertilization	as needed
Water Quality	Observed some primary productivity
Harvest Method	Seining and draining by gravity

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	5,340.20	4,656.00	+14.70	
Survival (%)	74.77	65.20	+14.67	
Sex ratio (% male)	-	-		
Mean SL (cm)	-	-		
Mean Weight (g)	166.66	125.00	+33.33	
CV of weight (%)	-	-		
FCR	1.22	1.46	-22.00	
Biomass (kg)	890.00	582.00	+52.92	
Total Biomass (kg)	890.00	590.00	+50.84	

Economic data (in Philippine Pesos):

Items	Qty (unit/m²)		Unit Price	Amount (P/m²/cropping)		Amount (P/m²/day)	
	GMT	**SRT**		**GMT**	**SRT**	**GMT**	**SRT**
Fingerlings	4.23	4.25	0.50/pc	2.2180	2.1256	0.0183	0.0199
Feeds							
starter	0.09	0.09	12.40/kg	1.1322	1.0850	0.0094	0.0100
grower	0.09	0.21	12.20/kg	1.1139	2.5925	0.0092	0.0240
finisher	0.49	0.21	11.40/kg	5.6080	2.3512	0.0463	0.0218
Fertilizer	n/a	n/a	n/a	n\a	n\a	n\a	n\a
Fuel/Electricity	n/a	n/a	n/a	n\a	n\a	n\a	n\a
Miscellaneous				0.6211	0.5952	0.0051	0.0056
Labor cost				0.3416	0.3274	0.0028	0.0031
Total Cost				**11.0348**	**9.0770**	**0.0912**	**0.0848**
Food Fish Sale							
Large	0.35	0.20	50.00/kg	17.3913	10.0625	0.1437	0.0932
Medium	0.14	0.11	40.00/kg	5.5155	4.4190	0.0455	0.0409
Small	0.07	0.03	30.00/kg	2.0124	1.0178	0.0166	0.0094
Total Sales				**24.9193**	**15.4994**	**0.2059**	**0.1449**
Net Return				**13.8845**	**6.4224**	**0.1147**	**0.0600**

Remarks and Observations:

No individual length, weight and sex data had been gathered in the experiment. This is because the farmer harvested the control fish ahead of the GMT without the project staff's knowledge. The farmer's reason was that their regular tilapia buyer from a distant place arrived and did not with to return empty handed and also wished to cover the travelling exprences incurred. They decided to harvest the control fish thinking that they have the authority to do it for they were their own fish. The farmer expressed sincere apology on this matter. However, the farmer were able to gather some interesting data listed above. The farmer has a very positive response with the fish since it was evident that the GMT population obtained better yield than the control.

Summary:

Despite the problem encountered in the experiment, it can still be considered a valuable trial.

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	5,340.20	4,656.00	+14.70	
Survival (%)	74.77	65.20	+14.67	
Sex ratio (% male)	-	-		
Mean SL (cm)	-	-		
Mean Weight (g)	166.66	125.00	+33.33	
CV of weight (%)	-	-		
FCR	1.22	1.46	-22.00	
Biomass (kg)	890.00	582.00	+52.92	
Total Biomass (kg)	890.00	590.00	+50.84	

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)		Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
	GMT	**SRT**		**GMT**	**SRT**	**GMT**	**SRT**
Fingerlings	4.23	4.25	0.50/pc	2.2180	2.1256	0.0183	0.0199
Feeds							
starter	0.09	0.09	12.40/kg	1.1322	1.0850	0.0094	0.0100
grower	0.09	0.21	12.20/kg	1.1139	2.5925	0.0092	0.0240
finisher	0.49	0.21	11.40/kg	5.6080	2.3512	0.0463	0.0218
Fertilizer	n/a	n/a	n/a	n\a	n\a	n\a	n\a
Fuel/Electricity	n/a	n/a	n/a	n\a	n\a	n\a	n\a
Miscellaneous				0.6211	0.5952	0.0051	0.0056
Labor cost				0.3416	0.3274	0.0028	0.0031
Total Cost				**11.0348**	**9.0770**	**0.0912**	**0.0848**
Food Fish Sale							
Large	0.35	0.20	50.00/kg	17.3913	10.0625	0.1437	0.0932
Medium	0.14	0.11	40.00/kg	5.5155	4.4190	0.0455	0.0409
Small	0.07	0.03	30.00/kg	2.0124	1.0178	0.0166	0.0094
Total Sales				**24.9193**	**15.4994**	**0.2059**	**0.1449**
Net Return				13.8845	6.4224	**0.1147**	**0.0600**

Remarks and Observations:

No individual length, weight and sex data had been gathered in the experiment. This is because the farmer harvested the control fish ahead of the GMT without the project staff's knowledge. The farmer's reason was that their regular tilapia buyer from a distant place arrived and did not with to return empty handed and also wished to cover the travelling exprences incurred. They decided to harvest the control fish thinking that they have the authority to do it for they were their own fish. The farmer expressed sincere apology on this matter. However, the farmer were able to gather some interesting data listed above. The farmer has a very positive response with the fish since it was evident that the GMT population obtained better yield than the control.

Summary:

Despite the problem encountered in the experiment, it can still be considered a valuable trial.

FELICIANO'S FARM

Location:	Ayala, Magalang, Pampanga
Culture unit:	Earthen ponds
Size of culture unit:	1,610 sq.m. (GMT) and 1,680 sq.m. (SRT)
Stocking Density:	7,000 and 7,200 @ 4.5 per sq.m.
Stocking Date:	December 22, 1993
Harvest Date:	April 22 (GMT) and April 8, 1994 (SRT)
Days of culture:	121 days (GMT) and 108 days (SRT)

ECONOMIC DATA

Inputs	GMT	Inputs	SRT
Stocks 7,000 fingerlings at P 0.50/pc	3,571.00	Stocks 7,200 fingerlings at P 0.50/pc	3,571.00
Feeds starter - 147 kgs at P 12.40/kg grower - 147 kgs at P 12.20/kg finisher - 792 kgs at P 11.40/kg	1,822.80 1,793.40 9,028,80	Feeds starter - 147 kgs at P 12.40/kg grower - 357 kgs at P 12.20/kg finisher - 346.5 kgs at P 11.40/kg	1,822.80 4,355.40 3,950.10
Salaries and Wages	550.00	Salaries and Wages	550.00
Miscellaneous	1,000.00	Miscellaneous	1,000.00
Total Production Cost	**17,766.00**	**Total Production Cost**	**15,249.30**

G M T		S R T	
Sales	Amount (P)	Sales	Amount (P)
large- 560 kgs at P 50.00 medium 222 kgs at P 40.00 small 108 kgs at P 30.00	28,000.00 8,880.00 3,240.00	338.1 kgs at P 50.00 185.6 kgs. at P 40.00 57.0 kgs at P 30.00	16,905.00 7,424.00 1,710.00
Production cost	17,766.00	Production Cost	15,249.30
Net Profit	**22,354.00**	Net Profit	**10,789.70**

CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**Mendoza's Farm**
Location:	Longos, Calumpit, Bulacan
Contact Person:	Mr. Jon Mendoza
Culture System:	"Backyard" type ponds
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	350
Stocking number\density:	1750 @ 5 per sq.m.
Stocking date:	May 27, 1993
Harvest date:	March 16, 1994
Culture Period:	289 days
GMT Origin:	From production of February 9, 1993
Control Origin:	Thailand strain produced by BFAR, Nueva Ecija
Growth Data File Name:	MENDOZA.WQ1
Economic Data File Name:	MENDOZA.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	3.92	3.94	-0.51	ns
SD	0.64	0.33		
Mean Weight (g)	2.55	2.25	+11.76	ns
SD	1.25	0.48		
Sex Ratio (%Male)	100			

Management System Operated:

Water Source:	Irrigation and deep-well water
Feeding:	no feeding
Fertilization	weekly application of 35 kg chicken manure per pond
Water Quality	Observed some primary productivity
Harvest Method	seining and draining by pump
Remarks:	Harvested

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	496.0	498.0	-0.4	
Survival (%)	28.3	28.4	-0.4	
Sex ratio (% male)	92.4	65.6	+40.8	
Mean SL (cm)	14.4	12.4	+16.1	
Mean Weight (g)	120.0	81.2	47.8	
CV of weight (%)	34.4	34.2	+0.6	
FCR	-	-	-	
Biomass (kg)	59.5	40.4	+47.3	
Recruit Biomass (kg)	-	27.9		
Total Biomass (kg)	59.5	68.3	-12.9	

Remarks and Observations:

Growth of fish was lousy due to high fish stocking density and absence of supplemental feeding. Eventhough there were matured rare females in GMT pond, no recruit was found possibly because we caught 2 kgs. (3 pcs.) mudfish. One 700 g african catfish was found in the control pond.

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)	Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
			GMT	MST	GMT	MST
Fingerlings	5.00	0.20/pc	1.000	1.000	0.0035	0.0035
Feeds	n\a	n\a	n\a	n\a	n\a	n\a
Fertilizer	0.11	18.00/kg	2.0571	2.0571	0.0071	0.0071
Fuel/Electricity	n\a	n\a	n\a	n\a	n\a	n\a
Miscellaneous	n\a	n\a	n\a	n\a	n\a	n\a
Labor cost			1.4750	1.4750	0.0051	0.0051
Total Cost			**4.5321**	**4.5321**	**0.0157**	**0.0157**
Food Fish Sale	0.17	40.00/kg	6.8000	n/a	0.0235	n/a
Food Fish Sale	0.12	40.00/kg	n/a	4.6171	n/a	0.0160
Total Sales			**6.8000**	**4.6171**	**0.0235**	**0.0160**
Net Return			2.2679	**0.0850**	**0.0078**	**0.0003**

Summary:

Although the growth in this trial was very slow due the management system, we can still justify that growing GMT (all-male) population was better than mixed sex population.

MENDOZA'S FARM

Location:	Longos, Calumpit, Bulacan
Culture unit:	Earthen ponds
Size of culture unit:	350 sq.m.
Stocking Density:	1,750 per pond @ 5 per sq.m.
Stocking Date:	May 27, 1993
Harvest Date:	March 16, 1994
Days of culture:	289 days

ECONOMIC DATA

Inputs		Amount (P)
Stocks	1,750 fingerlings at P 0.20/pc	350.00
Fertilizer	40 kg of chicken manure at P 18.00/kg	720.00
Labor		516.26
Total Production Cost		**1,586.25**

*the same production cost for GMT and SRT

GMT		MST	
	Amount (P)		Amount (P)
Sales 59.5 kgs at P 40.00	2,380.00	Sales 40.4 kgs at P 40.00	1,616.00
Production cost	1,586.25	Production Cost	1,586.25
Net Profit	**793.75**	Net Profit	**29.75**

FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**MFI Farming Project**
Location:	Lemery, Batangas
Contact Person:	Mr. Emil Ballesteros
Culture System:	Cage
Number of Culture Units:	Two (3)
Size of Culture Units (m^3):	40 m^2 or 120 m^3 (5m x 8m x 3m)
Stocking number\density:	3,000 @ 75 m^2 or @ 25 m^3
Stocking date:	November 13,1993
Harvest date:	January 20, 1994
Culture Period:	68 days
GMT Origin:	From production of July 16, 1993
Control Origin:	Thailand strain
Growth Data File Name:	MFI.WQ1
Economic Data File Name:	MFI.EDF.

Stocking Data:

	GMT-1	GMT-2	Control	% GMT difference	significance level
Mean SL (cm)	7.85	7.8	5.96	+24.07	ns
SD	0.93	0.91	0.93		
Mean Weight (g)	17.45	17.02	7.81	+55.24	ns
SD	6.77	6.56	3.76		
Sex Ratio (%Male)	100	100	64		

Management System Operated:

Water Source:	Pansipit River
Feeding:	*ad libitum* with Shuen Shen commercial feeds
Fertilization	none
Water Quality	Observed some primary productivity
Harvest Method	Concentrating the fish on one corner of the cage then scooping.

Remarks:

Great difference on stocking weight and length were due to the total change of the control fish. The cause of the very high mortality of the control population was unknown. Fish for replacement which should be of the same size as the GMT were not available. The very short culture period (two months) was due to the unexpected termination of the Meralco's cage culture project.

Harvest Data:

	GMT-1	GMT-2	Control	% difference	significance
Number harvested	1891	1722	1816	-0.005	
Survival (%)	63.0	57.4	60.5	-0.005	
Sex ratio (% male)	96.6	96.0	71.4	+35.000	
Mean SL (cm)	13.0	13.0	11.0	+18.180	
Mean Weight (g)	100.4	97.7	57.0	+73.770	
CV (%) of weight	40.4	42.2	46.8		
FCR	1.38		1.62	-14.81	
Biomass (kg)	190.6	170.0	103.5	+74.2	
Total Biomass (kg)	190.6	170.0	103.5	+ 74.2	

Remarks and Observations:

The great difference in yield between the GMT and the control population might be due to the initial stocking size of the fish and strain difference. Observed presence of O. mossambicus on the control population might be the another factor that attribute to its low yield. Number of harvested fish in each cage were similar although generally the survival was very low. The very variable water quality of the river could be the main reason of high mortality of stocked fish in the two cages. It is interesting to note that the "Blond" type *O. niloticus* becomes more prominent in color.

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)		Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
	GMT	MST		GMT	MST	GMT	MST
Fingerlings	25.00	25.00	0.25/pc	6.2500	6.2500	0.0919	0.0919
Feeds	2.11	1.40	10.75/kg	22.6758	15.0150	0.3335	0.2208
Cage Rent				4.6875	4.6875	0.0689	0.0689
Miscellaneous				2.0833	2.0833	0.0306	0.0306
Labor cost				40.3633	32.7025	0.0686	0.0686
Total Cost				**40.3633**	**32.7025**	**0.5936**	**0.4809**
Food Fish Sale	1.50	n/a	47.25/kg	70.8967	n/a	1.0426	n/a
Food Fish Sale	n/a	0.86	43.50/kg	n/a	37.3792	n/a	0.5497
Total Sales				**70.8967**	**37.3792**	**1.0426**	**0.5497**
Net Return				30.5333	4.6767	0.4490	0.0688

Summary:

A well conducted cage trial resulting in profitable culture of GMT. The almost break even result from the control were due to the very high mortality of the stocked fish which could possibly be attributed to the low quality of fish.

MFI CAGE FARM

Location:	Palanas, Lemery, Batangas
Culture unit:	River cages
Size of culture unit:	40 sq.m.
Stocking Density:	3,000 per cage
Stocking Date:	November 13, 1993
Harvest Date:	January 20, 1994

ECONOMIC DATA

Inputs	GMT	Control
Stocks 3,000 fingerlings at P 0.25/pc	750.00	750.00
Feeds commercial feeds at P 10.75/kg	2,721.10	1,801.80
Depreciation of cage at 562.50/cage	562.50	562.50
Miscalaneous	250.00	250.00
Labor	560.00	560.00
Total Production Cost	**4,843.60**	**3,924.3**

	GMT	**Control**
Sales	8,507.60	4,485.5
Production Cost	4,843.60	3,924.3
Net Profit	**3,664.00**	**561.20**

FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT) Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**MFI Farming Project - Second Trial**
Location:	Jala-jala. Rizal
Contact Person:	Mr. Martin de la Cruz
Culture System:	Concrete Tank
Number of Culture Units:	Three (3)
Size of Culture Units (m^3):	2m x $5m^2$
Stocking number\density:	50 @ 5 m^2
Stocking date:	October 12, 1994
Harvest date:	January 31, 1995
Culture Period:	111 days
GMT Origin:	From production of August, 1994
Control Origin:	Thailand strain
Growth Data File Name:	MFI-2.WQ1
Economic Data File Name:	MFI-2.EDF.

Stocking Data:

	GMT	SRT	MST	GMT & SRT difference	GMT & SRT difference	significance level
Mean SL (cm)	3.65	3.77	4.21	-3.18	-13.30	
SD	0.30	0.37	0.23			
Mean Weight (g)	1.93	2.26	2.96	-14.60	-34.80	
SD	0.52	0.56	0.51			
%Male	100	100	64			

Management System Operated:

Water Source:	deep well
Feeding:	twice a day using Shuen Shen commercial feeds
Fertilization	none
Water Quality	Observed some primary productivity
Harvest Method	tank draining and seining

Harvest Data:

	GMT	SRT	MST	GMT & SRT % difference	GMT & MST % difference	significance
Number harvested	41.00	37.00	38.00	+10.81	+7.89	
Survival (%)	82.00	74.00	76.00	+10.81	+7.89	
Sex ratio (% male)	97.50	94.60	60.53	+3.06	+61.08	
Mean SL (cm)	14.67	14.30	14.61	+2.59	+0.41	
Mean Weight (g)	114.87	108.18	104.44	+6.18	+9.98	
CV (%) of weight	22.70	28.91	32.04	-21.48	-29.15	
FCR	1.64	1.93	1.95	-15.02	-15.90	
Biomass (kg)	4.70	4.00	3.97	+7.50	+18.39	

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)	Unit Price	Amount (P/m^2/cropping)			Amount (P/m^2/day)		
			GMT	**SRT**	**MST**	**GMT**	**SRT**	**MST**
Fingerlings	5.00	0.20/pc	1.000	1.000	1.000	0.0090	0.0090	0.0090
Feeds	0.78	11.50/kg	8.9120	8.9120	8.9120	0.0803	0.0803	0.0803
Fertilizer			n\a	n\a	n\a	n\a	n\a	n\a
Electricity for pumping H_2O	5.55	0.50/m^3	2.7715	2.7715	2.7715	0.0250	0.0250	0.0250
Miscellaneous			1.0000	1.0000	1.0000	0.0090	0.0090	0.0090
Labor cost			2.0000	2.0000	2.0000	0.0180	0.0180	0.0180
Total Cost			**15.6870**	**15.6870**	**15.6870**	**0.1413**	**0.1413**	**0.1413**
Food Fish Sale	0.47	45.00/kg	21.1500	n/a	n/a	0.1905	n/a	n/a
Food Fish Sale	0.40	45.00/kg	n/a	18.0000	n/a	n/a	0.1622	n/a
Food Fish Sale	0.397	45.00/kg	n/a	n/a	17.8650	n/a	n/a	0.1609
Total Sales			**21.1500**	**18.0000**	**17.8650**	**0.1905**	**0.1622**	**0.1609**
Net Return			5.4630	2.3130	2.1780	**0.0492**	**0.0208**	**0.0196**

Remarks and Observations:

The tanks used in this trial were not really a grow-out culture tanks but SRT treatment tanks. The tanks were allowed to be used to test the GMT's growth performace in comparison with the SRT and MST populations being produced by the foundation. Better growth performance of GMT was obtained compared with SRT and MST (control) populations. The SRT population was observed to be slightly better than the MST. The better performance of the GMT population could be attributed to the very high percentage of male, better survival and the size uniformity of the fish that could be justified by the population's low coefficient of variation (CV). No recruitment was observed in all the treatments. This could probably be the reason why the growth performance difference of SRT and MST was slight.

The foundation was convinced of the GMT's good performance and they expressed their willingness to be involved in the dissemination of the fish to the farmers in the future.

Summary:

Another successful verification of the GMT population's good performance.

MFI Farm - Second Trial

Location:	Jala-jala, Rizal
Culture unit:	Concrete Tanks
Size of culture unit:	10 sq.m.
Stocking Density:	50 per tank , @ 5 per sq.m.
Stocking Date:	October 12, 1994
Harvest Date:	January 31, 1995
Days of culture	111 days

ECONOMIC DATA

COST OF PRODUCTION	
Particulars	**Amount**
Stocks 50 pcs at P 0.20/pc.	10.00
Commercial feeds 7.75 kgs at P 11.50/kg	89.12
Fuel-Cost of pumping water (P0.50/m^3 for 55.5 m^3)	27.75
Miscellaneous	10.00
Labor cost	20.00
Total Production Cost	**156.87**

* for GMT, SRT and MST

GMT		SRT		MST	
Sales at P45.00/kg 4.7 kgs	P 211.50	Sales 4.0 kgs	P 180.00	Sales 3.97 kgs	P 178.65
Production Cost	156.87		156.87		156.87
Net Profit	**54.63**		**23.13**		**21.78**

MFI Farm - Second Trial

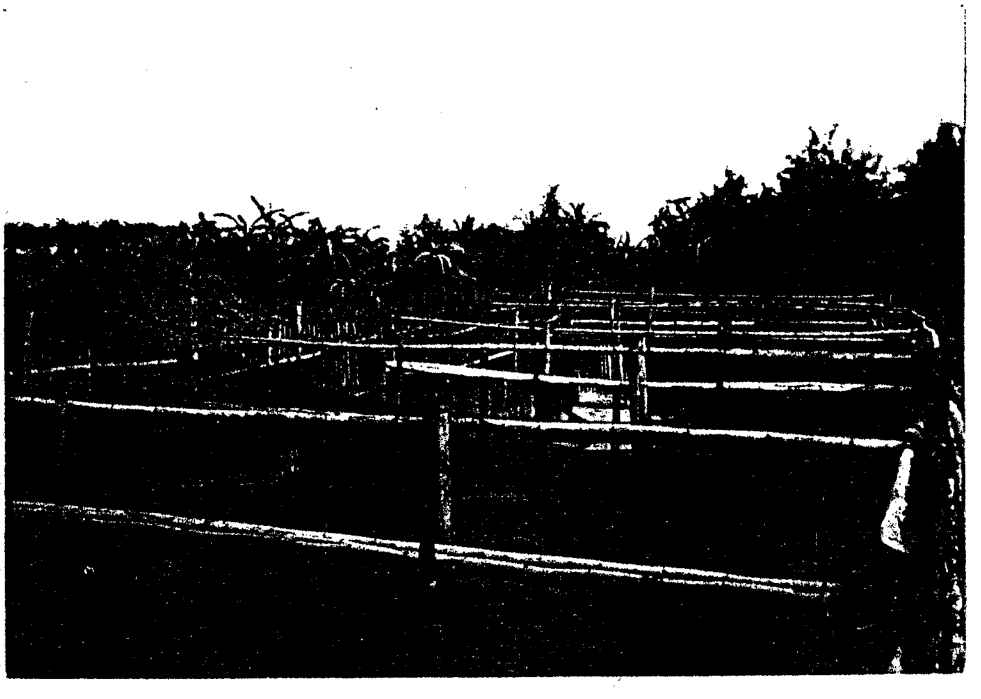
Location:	Jala-jala, Rizal
Culture unit:	Concrete Tanks
Size of culture unit:	10 sq.m.
Stocking Density:	50 per tank , @ 5 per sq.m.
Stocking Date:	October 12, 1994
Harvest Date:	January 31, 1995
Days of culture	111 days

ECONOMIC DATA

COST OF PRODUCTION	
Particulars	**Amount**
Stocks 50 pcs at P 0.20/pc.	10.00
Commercial feeds 7.75 kgs at P 11.50/kg	89.12
Fuel-Cost of pumping water (P0.50/m^3 for 55.5 m^3)	27.75
Miscellaneous	10.00
Labor cost	20.00
Total Production Cost	**156.87**

* for GMT, SRT and MST

GMT		**SRT**		**MST**	
Sales at P45.00/kg 4.7 kgs	P 211.50	Sales 4.0 kgs	P 180.00	Sales 3.97 kgs	P 178.65
Production Cost	156.87		156.87		156.87
Net Profit	**54.63**		**23.13**		**21.78**



FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**Obungen's Farm**
Location:	Magat Reservoir, Ramon, Isabela
Contact Person:	Mr. George Obungen
Culture System:	Lake cage
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	96
Stocking number\density:	3,500 @ 35 per sq.m.
Stocking date:	January 16, 1994
Tentative Harvest date:	June 19, 1994
Culture Period:	154 days
GMT Origin:	From production of August 9, 1993
Control Origin:	Singapore strain produced by Mr. Wesly del Rosario
Growth Data File Name:	OBUNGEN.WQ1
Economic Data File Name:	OBUNGEN.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	5.31	5.18	+2.44	ns
SD	0.50	0.63		
Mean Weight (g)	5.28	5.42	-2.58	ns
SD	1.57	1.75		
Sex Ratio (%Male)	90			

Management System Operated:

Water Source:	Magat Reservoir
Feeding:	Three (3) times a day with Robina commercial feeds
Fertilization	none
Water Quality	Observed some primary productivity
Harvest Method	Concentrating the fish on one corner of the cage then scooping

Remarks ans Observation

A month before the scheduled harvest of the fish, the cage of GMT fish was damaged due to strong wind. A big hole was found at the bottom of the cage that caused to escape about more than half of the fish population.

OBUNGEN CAGE PROJECT

Location: Magat Dam, Ramon, Isabela
Culture unit: Lake cages
Size of culture unit: 96 sq.m.
Stocking Density: 3,300 per cage
Stocking Date: January 16,1994
Harvest Date: June 19, 1994

ECONOMIC DATA

GMT		Control	
Stocks	Amount		Amount
3,300 pcs at P 0.30/pc.	990.00	3,300 pcs at P 0.30/pc.	990.00
Feeds (Vitarich feeds)			
1/2 bag fry crumble at P300/bag	150.00	1/2 bag fry crumble	150.00
8 bags Juvenile pellets at 290/bag	2,320.00	8 bags Juvenile pellets	2,320.00
10 bags Adult pellets at 285/bag	2,850.00	19 bags Adult pellets	5,415.00
Cage depreciation cost		Cage depreciation cost	
P 230.00/month/cage	1,150.00	P 230.00/cage	1,150.00
Labour cost - P 220/month/cage	1,100.00	Labour - P 220/month/cage	1,100.00
Diesel/crude oil - 4 li/month/cage	150.00	Diesel/crude oil	150.00
at P 7.50 per liter			
Total Production Cost	**8,710.00**		**11,275.00**

	GMT		Control
Sales		Sales	
172.0 kg at P 54.00/kg	9,288.00	285.0 kg at P 54.00/kg	15,390.00
Production Cost	8,710.00	Production Cost	11,275.00
Net Profit	**578.00**	**Net Profit**	**4,115.00**

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Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**Obungen's Farm (2nd Trial)**
Location:	Magat Reservoir, Ramon, Isabela
Contact Person:	Mr. George Obungen
Culture System:	Lake cage
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	72 m^2 or 360 m^3 (12m x 6m x 5m)
Stocking number\density:	3,000 @ 31.25/m^2 or @ 8.33.m^3
Stocking date:	July 27, 1994
Tentative Harvest date:	December 16, 1994
Culture Period:	163 days
GMT Origin:	From the production of April 1994
Control Origin:	Singapore strain produced by Mr. Wesly del Rosario
Growth Data File Name:	OBUNGEN2.WQ1
Economic Data File Name:	OBUNGEN2.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	4.81	4.98	-03.00	ns
SD	0.50	0.63		
Mean Weight (g)	4.70	5.28	-10.00	ns
SD	1.57	1.75		
Sex Ratio (%Male)	100			

Management System Operated:

Water Source:	Magat Reservoir
Feeding:	Three (3) times a day with Robina commercial feeds
Fertilization	none
Water Quality	Observed some primary productivity
Harvest Method	Concentrating the fish on one corner of the cage then scooping
Remarks:	Harvested

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	2293.00	1573.00	+45.77	
Survival (%)	76.00	52.00	+45.77	
Sex ratio (% male)	100.00	87.00	+14.94	
Mean SL (cm)	18.34	18.67	- 01.76	
Mean Weight (g)	288.29	308.35	- 06.50	
CV (%)	37.89	31.76	- 19.30	
FCR	2.80	3.81	- 26.51	
Biomass (kg)	661.00	485.00	+36.29	
Total Biomass (kg)	661.00	485.00	+36.29	

Economic data (in Philippine Pesos):

Items	Qty ($unit/m^2$)	Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
			GMT	**MST**	**GMT**	**MST**
Fingerlings	8.33	0.30/pc	2.5000	2.5000	0.0153	0.0153
Feeds	5.14	11.40/kg	58.5833	58.5833	0.3594	0.3594
Cage Rent			3.1944	3.1944	0.0196	0.0196
Miscellaneous			1.3889	1.3889	0.0085	0.0085
Labor cost			2.7778	2.7778	0.0170	0.0170
Total Cost			**68.4444**	**68.4444**	**0.4199**	**0.4199**
Food Fish Sale	1.84	53.00/kg	97.3139	n/a	0.5970	n/a
Food Fish Sale	1.35	53.00/kg	n/a	71.4028	n/a	0.4381
Total Sales			**97.3139**	**71.4028**	**0.5970**	**0.4381**
Net Return			28.8694	2.9583	**0.1771**	**0.0181**

Remarks and Observations:

This second trial in Obungen's farm was considered more successful than the first trial. Although individual weight of GMT population was lower compared to the control population, still better yield on GMT population was obtained. This was due to the GMT's higher survival.

High percentage male of the control population was noticeable considering that the farmer claimed he purchased mixed sex population. This percentage however was observed to be much higher than the sex reversed populations on the few trials we had on-farm. Although this high percentage of male in the control (mixed sex) population was unexplainable, there are posibilities that this was due to sample selection (non-ramdom) or that this is a nearly tall male population.

The farmer was very much convinced of the exemplary performance of the GMT population. However, there was one comment/observation the farmer want to stress and this is in relation to his observation on the difference in growth perfomance of the wild type and Blond type GMT. He commented that the Blond type GMT grew slower (and smaller in size at harvest) than the wild type. Since there has been no proof or available data to answer this comment, it is therefore suggested to make an on-station experiment to properly evaluate the said comment.

Summary

A successful cage trial in resevoir environment.

OBUNGEN CAGE PROJECT-2

Location:	Magat Dam, Ramon, Isabela
Culture unit:	Lake cages
Size of culture unit:	96 sq.m.
Stocking Density:	3,000 per cage
Stocking Date:	July 27, 1994
Harvest Date:	Jan 19, 1995
Days of culture	163 days

ECONOMIC DATA

COST OF PRODUCTION	
Particulars	**Amount**
Stocks 3,000 pcs at P 0.30/pc.	900.00
Feeds (Vitarich feeds) 74 bags at P 285.00/bag	21,090.00
Cagerent P 230.00/month/cage	1,150.00
Labour cost (P 1,200/mo, 20 cages, 2 laborer, 5 months and P 400.00 incentive)	1,000.00
Miscllaneous	500.00
Total Production Cost	**24,640.00**

* both for GMT and Control

	Control		**GMT**
Sales		Sales	
485.0 kg at P 53.00/kg	25,705.00	661.0 kg at P 53.00/kg	35,033.00
Production Cost	24,640.00	Production Cost	24,640.00
Net Profit	**1,065.00**	**Net Profit**	**10,393.00**

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Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**Pamintuan's Farm**
Location:	San Roque, Mexico, Pampanga
Contact Person:	Benigno Cunanan and Mrs. Pamintuan
Culture System:	Ponds
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	1,850 (SRT) and 2,000 (GMT) sq.m.
Stocking number\density:	13,000 and 15,000 @ 7,5 per sq.m.
Stocking date:	December 17, 1993
Tentative Harvest date:	May 17, 1994
Culture Period:	176 days
GMT Origin:	From production of September 6, 1993
Control Origin:	Sex Reversed Tilapia produced by Robert So's Farm
Growth Data File Name:	PAMINTUA.WQ1
Economic Data File Name:	PAMINTUA.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	3.25	2.68	+17.54	ns
SD	0.66	0.73		
Mean Weight (g)	1.72	0.96	+44.18	ns
SD	1.05	0.86		
Sex Ratio (%Male)	98			

Management System Operated:

Water Source:	pump/deep-well
Feeding:	Twice a day with Robina commercial feeds
Fertilization	as needed
Water Quality	Observed primary productivity
Harvest Method	Seining and draining by pump

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	13,780.00	8,442.00	+ 41.47	
Survival (%)	91.86	64.93	+ 41.47	
Sex ratio (% male)	94.00	75.00	+25.33	
Mean SL (cm)	14.63	16.13	- 9.30	
CV of length (%)	7.33	8.55	- 14.27	
Mean Weight (g)	130.62	177.69	- 26.49	
CV of weight (g)	21.41	26.78	- 20.05	
FCR	2.08	1.9	+9.47	
Biomass (kg)	1,800.00	1,500.00	+ 20.00	
Recruit Biomass (kg)	40.00	65.00	- 38.46	
Total Biomass (kg)	1,840.00	1,565.00	+ 17.57	

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)		Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
	GMT	**SRT**		**GMT**	**SRT**	**GMT**	**SRT**
Fingerlings	7.00	7.00	0.30/pc	2.2500	2.1081	0.0128	0.0120
Feeds	1.71	1.64	11.00/kg	18.7812	17.9904	0.1067	0.1022
Fertilizer	0.02	0.02	8.00/kg	0.1600	0.1730	0.0009	0.0010
Fuel/Electricity	0.18	0.20	22.00/kwh	4.0000	4.3233	0.0227	0.0246
Miscellaneous				2.8522	2.8196	0.0162	0.0160
Labor cost				3.3303	3.6004	0.0189	0.0205
Total Cost				**31.3737**	**31.0158**	**0.1783**	**0.1763**
Foos Fish Sale	0.54	0.81	45.00/kg	22.5000	36.4865	0.1278	02073
Food Fish Sale	0.43	n/a	40.00/kg	16.0000	n/a	0.0909	n/a
Total Sales				**38.5000**	**36.4865**	**0.2188**	**0.2073**
Net Return				7.1263	5.4707	**0.0405**	**0.0311**

Remarks and Observations:

The three ponds on this farm were in sequence with water from the well flowing consecutively through the three ponds. The GMT was in the second pond, the SRT control in the third. It is possible that the third pond is advantaged by this set up as some of the primary productivity from the first two ponds, ends up in the third.

Recruitment in GMT pond were due to the improper screening of the pond's inlet pipe. This could be further justified by the very low percentage of female in the population which would result to nil reproduction. Recruits from GMT and Control ponds were given to the neighboring farmers for food. Low average weight of GMT compared with the control could be attributed to the very high survival rate and unwanted recruits. However, still it was proven that GMT population had better yield compared with the control population tested.

Farmers feedback were not that satisfactory since they were expecting that GMT could grow much faster or bigger than the control fish in terms of individual weight. They said they want bigger fish for it commence better price. We had a hard time convincing the farmer of the possible causes of the result.

Summary:

Although the farmer who tested the fish was not satisfied with the result, still the GMT population obtained better yield compared with the control population.

PAMINTUAN FARM

Location:	San Roque, Mexico, Pampanga
Culture unit:	Earthen ponds
Size of culture unit:	1,850 (SRT) and 2,000 m^2.(GMT)
Stocking Density:	13,000 and 15,000 per pond
Stocking Date:	December 17, 1993
Harvest Date:	May 17, 1994
Days of culture:	176 days

ECONOMIC DATA

COST OF PRODUCTION			
Inputs	GMT	Inputs	SRT
Stocks 15,000 fingerlings at P 0.30 /pc	4,500.00	13,000 fingerlings	3,900.00
Feeds 3,414.77 kgs at P 11.00/kg	37,562.47	3,025.66kgs.	33,282.26
Fertilizer (16-20-0) (40kg/bag)	320.00		320.00
Elect.(363.6 kwh at P 22/kwh)	8,000.00	Electricity	8,000.00
Salaries and Wages	6,660.67	Salaries and Wages	6,660.67
Miscellaneous	5,704.31	Miscelaneous	5,216.29
Total Production Cost	**62,747.45**	**Total Production Cost**	**57,379.22**

* the same production cost for GMT and SRT

SRT		**GMT**	
Sales	Amount (P)	Sales	Amount (P)
1,500 kgs at P 45.00	67,500.00	1,000 kgs at P 45.00 800 kgs. at P 40.00	45,000.00 32,000.00
Production cost	57,379.22	Production Cost	62,747.45
Net Profit	**10,120.75**	Net Profit	**14,252.55**

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Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**PSU Production farm**
Location:	PSU, Coll. of Fisheries, Binmally, Pangasinan
Contact Person:	Ms. Cornelia Estabillo
Culture System:	"Backyard" type ponds
Number of Culture Units:	Four (4)
Size of Culture Units (m^2):	130
Stocking number\density:	390 @ 3 per sq.m
Stocking date:	August 5, 1993
Harvest date:	December 8, 1993
Culture Period:	125 days
GMT Origin:	From production of March 23, 1993
Control Origin:	Israel SRT produced by GMIT-TAD project From production of March 30, 1993
Growth Data File Name:	PSU-Farm.WQ1
Economic Data File Name:	PSU.EDF

Stocking Data:

	GMT 1	GMT 2	Control 1	Control 2	% GMT difference	Significance level
Mean SL (cm)	4.05	4.01	4.19	3.78	+1.25	ns
SD	0.95	0.85	1.05	0.80		
Mean Weight (g)	2.81	2.69	3.78	1.85	-2.31	ns
SD	1.98	1.78	3.70	2.68		

Management System Operated:

Water Source:	Rainfed
Feeding:	Occasionally with powdered rice bran/fish meal mix
Fertilization	Twice a month with 1,000 kg/ha of chicken manure and 50 kg/ha of 16-20-0
Water Quality	Observed some primary production, slightly brackish at time (up to 2ppt)
Harvest Method	Seined then drained with pump and remaining fish collected from pond bottom.
Remarks:	Relatively poor management resulting in poor growth. Harvest was early due to water shortage.

Harvest Data:

	GMT 1	GMT 2	Control 1	Control 2	% GMT difference	significance
Number harvested	375	352	340	359	+4.00	ns
Survival (%)	96.15	90.25	87.18	92.05	+4.00	
Sex ratio (% male)	100	100	62.65	61.00	+61.76	***
Mean SL (cm)	11.01	11.50	10.45	10.28	+8.54	ns
Mean Weight (g)	49.20	58.78	46.13	39.58	+26.00	ns
CV of weight (%)	mean=	33.90	mean=	35.50	-04.51	
FCR	mean=	2.59	mean=	2.26	+14.60	
Biomass (kg)	18.45	20.69	15.68	14.21	+30.95	ns
Recruit Mean Weight (g)	13.89	16.78	0.83	1.25	+1,378.5	***
Recruit Biomass (kg)	1.8	3.8	0.10	5.5	0.00	ns
Total Biomass (kg)	20.25	24.49	15.78	19.17	+26.06	*

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)		Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
	GMT	**MST**		**GMT**	**MST**	**GMT**	**MST**
Fingerlings	3.00	3.00	0.20/pc	0.6154	0.6154	0.0049	0.0049
Feeds							
Rice bran	0.27	0.18	5.50/kg	1.5038	1.0154	0.0120	0.0081
Fish meal	0.12	0.08	17.00/kg	1.9969	1.3468	0.0160	0.0108
Fertilizer							
Ammophos	0.22	0.22	6.40/kg	1.4078	1.4078	0.0113	0.0113
Organic	0.38	0.38	3.00/kg	1.1538	1.1538	0.0092	0.0092
Fuel/Electricity							
SAE oil	0.004	0.004	47.00/li	0.1808	0.1808	0.0014	0.0014
Gas	0.02	0.02	7.27/li	0.1400	0.1400	0.0011	0.0011
Diesel	0.02	0.02	9.80/li	0.1885	0.1885	0.0015	0.0015
Miscellaneous				0.9615	0.9615	0.0077	0.0077
Labor cost				3.6058	3.6058	0.0288	0.0288
Total Cost				**11.7542**	**10.6152**	**0.0940**	**0.0849**
Food Fish Sale	0.30	n/a	45.00/kg	13.5000	n/a	0.1080	n/a
Food Fish Sale	n/a	0.23	40.00/kg	n/a	8.9231	n/a	0.0714
Fingerlings #12	1.31	n/a	0.65/pc	0.8500	n/a	0.0068	n/a
Fingerlings #17	2.62	n/a	0.30/pc	0.7846	n/a	0.0063	n/a
Fingerlings #24	n/a	9.23	0.15/pc	n/a	1.3846	n/a	0.0111
Fingerlings #22	n/a	5.38	0.15/pc	n/a	0.8077	n/a	0.0065
Total Sales				**15.1346**	**11.1154**	**0.1211**	**0.0889**
Net Return				**3.3804**	**0.5002**	**0.0270**	**0.0040**

Remarks and Observations:

There was almost certainly a flooding event during the period of this grow out, most likely typhoon Kadyang on October 9. It is likely that some fry migrated from one of the Control (SRT) ponds to a GMT stocked pond. The even and large size of recruits in the GMT 2 support this theory of a single recruitment event. The sex ratio of the recruits (close to 1:1 or biased to female) also indicate that they could not be derived from a GMT female which spawned and died before harvest. Six mudfish (*Channa striata*) were harvested from SRT 1 accounting for the lack of recruits. One mudfish and one African catfish (*Clarias gariepinus*) were harvested from GMT 1.

Summary:

A useful result from a well conducted trial. It is unfortunate that the sex reversal was not effective and perhaps this trial should be considered as a comparison with MST from the "Israel" strain.

PSU-CF FARM

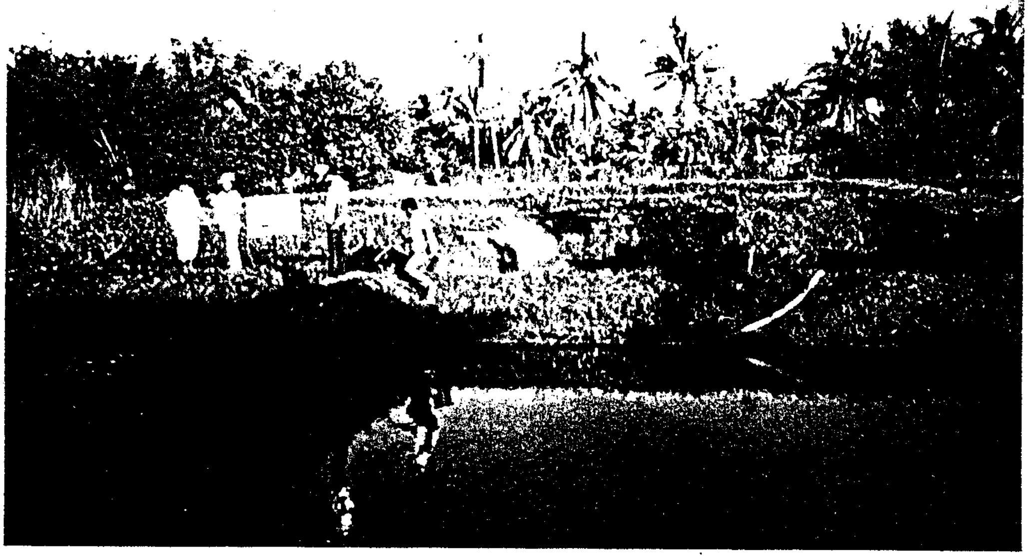
Location: Binmaley, Pangasinan
Culture unit: "Backyard" type earthen ponds
Size of culture unit: 130 sq.m.
Stocking Density: 390 per pond
Stocking Date: August 5, 1993
Harvest Date: December 8, 1994

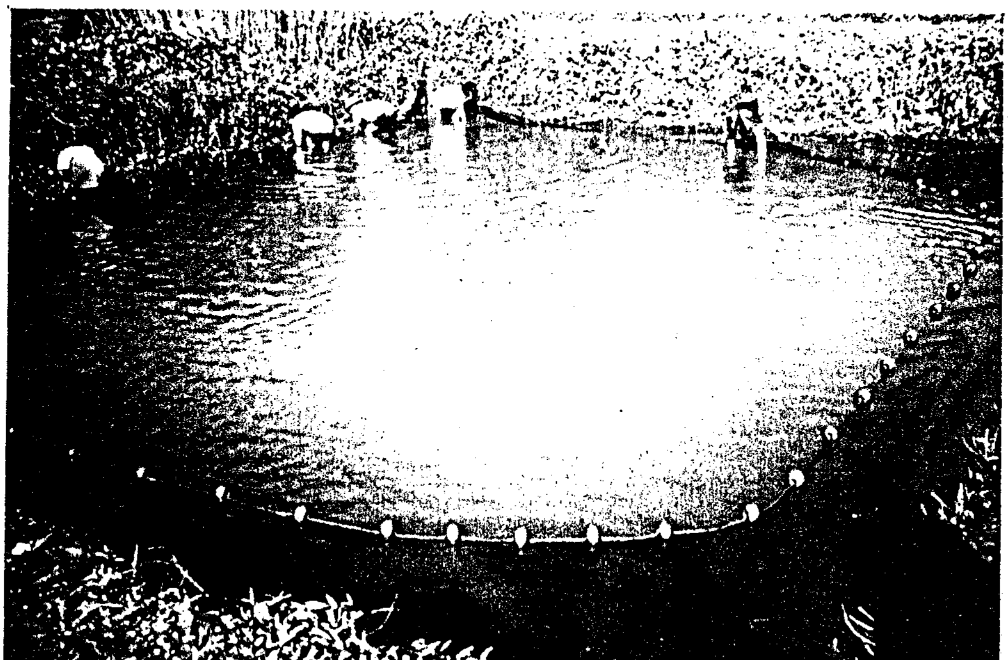
ECONOMIC DATA

Inputs		G M T	S R T
Fingerlings	400 pcs at 0.20/pc	80.00	80.00
Fertilizer	28.6 kgs Ammophos at P 6.40/kg	183.02	183.02
	50 kgs Alpha S P Organic fertilizer at P 3.00/kg	150.00	150.00
Feeds	Fine rice bran at P 5.50/kg	195.50	132.00
	Fish meal at P 17.00/kg	259.60	175.08
Fuel	0.5 li SAE oil at P 47.00/liter	23.50	23.50
	2.5 li Gasoline at P 7.27.00/liter	18.20	18.20
	2.5 li Diesel at P 9.80/liter	24.50	24.50
Miscallanoue		125.00	125.00
Labor		468.75	468.75
Total Production Cost		1,528.05	1,379.97

* two ponds per treatment

G M T		S R T	
	Amount (P)		Amount (P)
Sales		**Sales**	
Marketable fish 39 kg at P 45.00/kg	1,755.00	Marketable fish 30 kg at P 40.00/kg	1,160.00
Fingerlings		Fingerlings	
170 pcs #12 at P 0.65@	110.50	1,200 pcs #24 at P 0.15@	180.00
340 pcs #17 at P 0.30@	102.00	700 pcs #22 at P 0.15@	105.00
Production cost	1,528.05	**Production Cost**	1,379.97
Net Profit	**439.45**	Net Profit	**65.03**





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Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**Puyat FARM**
Location:	Brgy. Soledad, Sta. Rosa, Nueva Ecija
Contact Person:	Mr. Jonathan Reyes
Culture System:	Conctere tanks
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	300
Stocking number\density:	1,500 @ 5 per sq.m.
Stocking date:	July 05, 1994
Harvest date:	October 25, 1994
Culture Period:	102 days
GMT Origin:	From production of April 17, 1994
Control Origin:	Sex reversed tilapia produced in the farm
Growth Data File Name:	PUYAT.WQ1
Economic Data File Name:	PUYAT.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	3.01	2.59	+16.22	ns
SD	0.25	0.38		
Mean Weight (g)	1.00	0.76	+31.58	ns
SD	0.24	.031		
Sex Ratio (%Male)				

Management System Operated:

Water Source:	Deep-well
Feeding:	Three (3) times a day with farmers formulated feeds
Fertilization	none
Water Quality	Observed some primary productivity
Harvest Method	Seining and draining with pump

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	1,437	1,344	+6.92	
Survival (%)	95.80	89.60	+6.92	
Sex ratio (% male)	100.00	100.00	-	
Mean SL (cm)	16.48	16.98	-2.94	
Mean Weight (g)	145.24	175.59	-17.28	
CV of weight	24.52	33.74	-27.33	
FCR	1.44	1.64	-12.20	
Total Biomass (kg)	258.00	227.00	+13.66	

Remarks and Observations:

A successful tank trial. Although the mean weight of GMT fish at harvest was lower compared to SRT, still better yield in GMT was obtained. This is due to the better survival rate in GMT population. It is interesting to note that despite the similarity of the GMT and SRT in sex ratio (both 100%), the GMT population still obtain better growth performance. Better coefficient of variation (CV) in GMT population was also observed which reveals that GMT had relatively more uniform sizes compared to the SRT. Once again culturing genetically manipulated male tilapia proves its advantage.

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)	Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
			GMT	SRT	GMT	SRT
Fingerlings	5.00	0.20/pc	1.0000	1.0000	0.0098	0.0098
Feeds	1.24	12.50/kg	15.5000	15.5000	0.1520	0.1520
Fertilizer			n\a	n\a	n\a	n\a
Electricity for pumping water	5.00	1.00/m^3	5.0000	5.0000	0.0490	0.0490
Miscellaneous			1.6667	1.6667	0.0163	0.0163
Labor cost			1.7000	1.7000	0.0167	0.0167
Total Cost			24.8667	24.8667	0.2438	0.2438
Food Fish Sale	0.86	45.00/kg	38.7000	n/a	38.7000	n/a
Food Fish Sale	0.76	45.00/kg	n/a	34.0500	n/a	34.0500
Total Sales			38.7000	34.0500	38.7000	34.0500
Net Return			13.8333	9.1833	13.8333	9.1833

Summary

A successful tank trial using an intensive culture system

PUYAT Farm

Location:	Sta. Rosa, Nueva Ecija
Culture unit:	Concrete Tanks
Size of culture unit:	300 sq.m.
Stocking Density:	1,500 per tank , @ 5 per sq.m.
Stocking Date:	July 05, 1994
Harvest Date:	October 25, 1994
Days of culture	102 days

ECONOMIC DATA

COST OF PRODUCTION	
Particulars	**Amount**
Stocks 1,500 pcs at P 0.20/pc.	300.00
Feeds (formulated feeds) 372 kgs at P 12.50/kg	4,650.00
Labour cost (P 5.0/day for 102 days)	510.00
Cost of pumping water (P1.00/m^3 for 1,500 m^3)	1,500.00
Miscellaneous	500.00
Total Production Cost	**7,460.00**

* both for GMT and SRT

	GMT		SRT
Sales		Sales	
258.0 kgs at P45.00/kg	11,610.00	227 kgs at P 45.00/kg	10,215.00
Production Cost	7,460.00	Production Cost	7,460.00
Net Profit	**4,150.00**	**Net Profit**	**2,755.00**

FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**Sibul Cage Project**
Location:	Sibul, Talavera, Nueva Ecija
Contact Person:	Mr. Tommy Ellana
Culture System:	Impoundment cage
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	96 m^2 or 288 m^3 (12m x 8m x 3m)
Stocking number\density:	2,000 @ 20/ m^2 @ 6.94 m^3
Stocking date:	December 20, 1993
Tentative Harvest date:	May 20, 1994
Culture Period:	151 days
GMT Origin:	From production of September 6, 1993
Control Origin:	Farmers fish
Growth Data File Name:	SIBUL.WQ1
Economic Data File Name:	SIBUL.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	5.13	5.10	+0.58	ns
SD	0.43	0.66		
Mean Weight (g)	5.39	5.32	+1.30	ns
SD	1.32	2.20		
Sex Ratio (%Male)	90			

Management System Operated:

Water Source:	Rain and Irrigation water
Feeding:	Three times a day with B-meg commercial feeds
Fertilization	none
Water Quality	Observed some primary productivity
Harvest Method	Concentrating the fish on one corner of the cage then scooping
Remarks:	Harvested

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	1,218.8	1,174.1	+3.8	
Survival (%)	40.6	39.1	+3.8	
Sex ratio (% male)	92.0	55.0	+67.3	
Mean SL (cm)	14.8	13.7	+8.0	
Mean Weight (g)	125.7	93.2	+35.2	
Coefficient of variation (g)	23.5	29.7	-2.1	
Total Biomass (kg)	153.2	109.4	+40.0	

Remarks and Observations:

A small natural impoundment in Sibul, Talavera, Nueva Ecija is being used for fish cage operation by farmers. The impoundment's water supply depends on rain and NIA irrigation water. Its natural productivity was considerably low compared to reservoir and lakes.

A trial was conducted to assess the growth performance of GMT in this particular type of environment. Observed slow growth of fish were due to the low natural productivity of the impoundment and lack of artificial/suplemental feeding. The culture period lasted for eight months. The very low survival of GMT and control were caused by the on-set of eye disease during the first month of the culture period. However, despite the out break of disease and incomplete feeding, GMT obtained higher yield compared to the control.

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)	Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
			GMT	**MST**	**GMT**	**MST**
Fingerlings	6.94	0.25/pc	2.6042	2.6042	0.0172	0.0172
Feeds	0.043	10.56/kg	0.4583	0.4583	0.0030	0.0030
Cage Rent			1.0417	1.0417	0.0069	0.0069
Miscellaneous			1.7361	1.7361	0.0115	0.0115
Labor cost			1.8750	1.8750	0.0124	0.0124
Total Cost			**7.7153**	**7.7153**	**0.0511**	**0.0511**
Food Fish Sale	0.53	55.00/kg	29.2569	n/a	0.1938	n/a
Food Fish Sale	0.38	55.00/kg	n/a	20.9019	n/a	0.1384
Total Sales			**29.2569**	**20.9019**	**0.1938**	**0.1384**
Net Return			**21.5417**	**13.1866**	**0.1427**	**0.0873**

Summary:

Another successful cage trial in natural impoundment environment.

SIBUL CAGE PROJECT

Location:	Sibul, Talavera, Nueva Ecija
Culture unit:	Lake cages
Size of culture unit:	96 sq.m.
Stocking Density:	3,300 per cage
Stocking Date:	December 20, 1994
Harvest Date:	August 10, 1994

ECONOMIC DATA

COST OF PRODUCTION

Inputs	**Cost**
Stocks 3000 fingerlings at P 0.25/pc	750.00
Feeds 0.5 bags of commercial feeds at P 264.00/bag (25 kg/bag)	132.00
Cage rent	300.00
Miscellaneous	500.00
Labor	540.00
Total Production Cost	**2,222.00**

* the same for GMT and MST

	GMT		**Control**
Sales 153.2 kg at P 55.00/kg	8,426.00	Sales 109.45 kg at P 55.00/kg	6,019.75
Production Cost	2,222.00	Production Cost	2,222.00
Net Profit	**6,204.00**	**Net Profit**	**3,797.75**

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Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**SMFI farm**
Location:	Calatrava, Negros Occidental
Contact Person:	Ms. Ma. Rosa Solis
Culture System:	Conctere tanks
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	200
Stocking number\density:	710 @ 3.55 per sq.m.
Stocking date:	March 20, 1994
Harvest date:	July 22 (GMT) and July 28, 1994 (SRT)
Culture Period:	124 days (GMT) and 130 days (SRT)
GMT Origin:	From production of April 17, 1994
Control Origin:	Sex reversed tilapia produced in Guerrero's farm
Growth Data File Name:	SMFI.WQ1
Economic Data File Name:	SMFI.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	8.88	6.05		ns
SD	6.32	3.01		
Mean Weight (g)	18.58	5.35		ns
SD	1.02	0.89		
Sex Ratio (%Male)	100	100		

Management System Operated:

Water Source:	Deep-well
Feeding:	Three (3) times a day with B-meg feeds
Fertilization	none
Water Quality	Observed some primary productivity
Harvest Method	Seining and draining with pump

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	710.00	642.00	+10.59	
Survival (%)	100.00	90.42	+10.60	
Sex ratio (% male)	99.20	97.80	+01.43	
Mean SL (cm)	17.70	16.62	+06.50	
Mean Weight (g)	215.4	168.00	+28.21	
CV of weight (%)	24.35	33.85	-28.06	
FCR	1.62	1.72	-05.81	
Biomass	156.29	107.85	+44.91	
Biomass of recruits (g)	0.07	16.45	-99.57	
Total Biomass (kg)	156.36	124.30	+25.79	

Remarks and Observations:

Another tank trial that revealed an excellent result. It could be given high emphasis that despite the nearly similar sex ratio of the GMT and SRT, the yield of the GMT population exceed to about 25.8% over the SRT population. This could probably be attributed to the strain difference which gave us the conclusion that the Egypt Swansea strain where the GMT developed was a better performing strain. The difference in yield could also be due to the uniformity of fish sizes that could be justified by the lower CV of the GMT population. Recruits found in SRT population were much higher than the GMT even though the difference of GMT and SRT in sex ratio was only 1.43%.

A second, mixed-sex, control was part of this experiment. It was obtained from the BFAR station near CLSU and was purprotedly the GIFT tilapia. This was matched closely for size with the GMT. At the end of the experiment we were told by San Miguel that they had signed an agreement with ICLARM, such that the results from the evaluation of the GIFT, should not be released to any third party so we did not get the control data.

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)		Unit Price	Amount (P/m^2/cropping)		Amount (P/m^2/day)	
	GMT	SRT		GMT	SRT	GMT	SRT
Fingerlings	3.55	3.55	0.20/pc	0.7100	0.7100	0.0057	0.0055
Feeds	1.27	0.93	12.50/kg	15.8820	11.5870	0.1281	0.0891
Fertilizer	n/a	n/a	n/a	n\a	n\a	n\a	n\a
Electricity for water pumping	9.67	9.86	0.50/m^3	4.9275	4.8308	0.0397	0.0372
Miscellaneous				1.7900	1.7900	0.0144	0.0138
Labor cost				3.1000	3.2500	0.0250	0.0250
Total Cost				**26.4095**	**22.1678**	**0.2130**	**0.1705**
Food Fish Sale	0.78	0.54	45.00/kg	35.1653	24.2663	0.2836	0.1867
Total Sales				35.1653	24.2663	**0.2836**	**0.1867**
Net Return				8.7558	2.0985	**0.0706**	**0.0161**

Summary

A significant and successful trial in tank environment, compared with a popular and purpotedly fast growing fish, namely Dr. Guerrero's well sex reversed Egyptian strain.

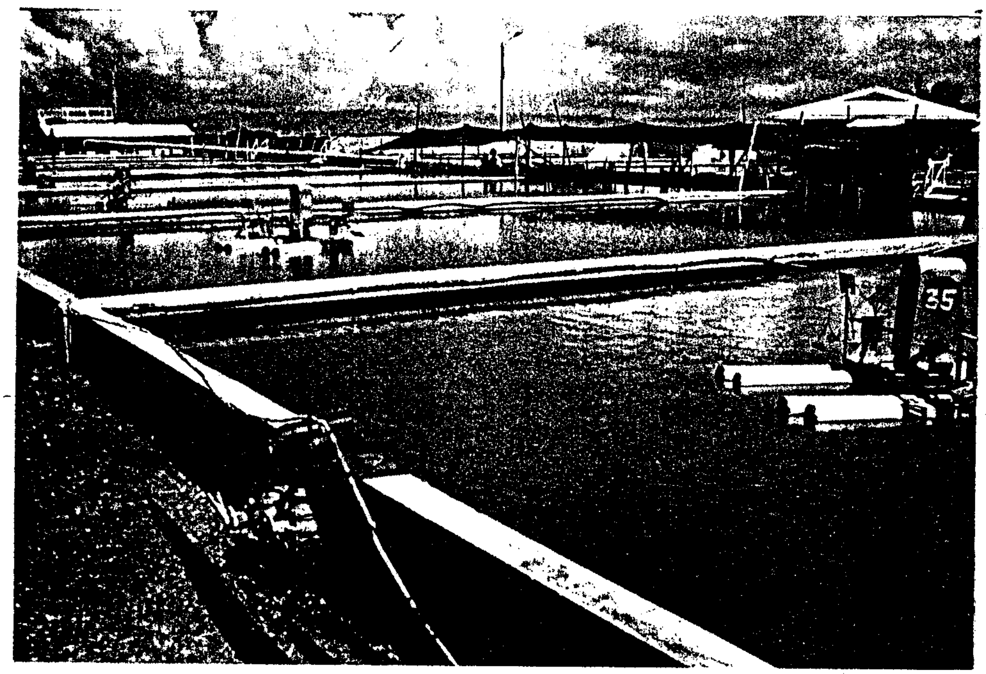
SMFI FARM

Location:	Calatrava, Negros Occidental
Culture unit:	Concrete tanks
Size of culture unit:	200 sq.m.
Stocking Density:	710 @ 3.55 per sq.m.
Stocking Date:	March 20, 1994
Harvest Date:	July 22, 1994 (GMT) and July 28, 1994 (SRT)
Days of culture:	124 days (GMT) and 130 days (SRT)

ECONOMIC DATA

COST OF PRODUCTION			
Inputs	**GMT**	**Inputs**	**SRT**
Stocks 710 fingerlings at P 0.20/ps	142.00	Stocks 710 fingerlings at P 0.20/ps	142.00
Feeds- B-meg commercial feeds 254.11 kgs at P 12.50/kg	3,176.40	Feeds- B-meg commercial feeds 185.39 kgs at P 12.50/kg	2,317.40
Fuel -Cost of pumping water 1,932 m3 at P 0.50/m3	966.15	Fuel- Cost of pumping water 1,971.6 m3 at P 0.50/m3	985.50
Miscellaneous	358.00	Miscellaneous	358.00
Labor cost	650.00	Labor cost	650.00
Total Production Cost	**5,281.90**	**Total Production Cost**	**4,433.55**

GMT		SRT	
	Amount (P)		Amount (P)
Sales 156.29 kgs at P 45.00/kg	7,033.05	Sales 107.85 kgs at P 45.00/kg	4,853.25
Total Production Cost	5,281.90	Total Production Cost	4,433.55
Net Profit	**1,751.15**	Net Profit	**419.70**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Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**SMP-PMPC Farm**
Location:	Aya Dam, Pantabangan, Nueva, Ecija
Contact Person:	Mr. Led de la Cruz and Mr. Carlos Linsangan
Culture System:	Lake cage
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	96
Stocking number\density:	2,000 @ 20.8 per sq.m.
Stocking date:	September 10,1993
Harvest date:	February 10,1994
Culture Period:	Five (5) months
GMT Origin:	From production of July 16,1993
Control Origin:	Israel Strain produced by GMIT-TAD Project From production of July 14, 1994
Growth Data File Name:	SMP-PMPC.WQ1
Economic Data File Name:	SMP-PMPC.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	3.34	3.33.	0.30	ns
SD	0.48	0.33		
Mean Weight (g)	1.25	1.35	-7.41	ns
SD	0.42	0.34		
Sex Ratio (%Male)	100	58	72.0	

Management System Operated:

Water Source:	Aya Dam Reservoir
Feeding:	Irregular feeding with Robina commercial feeds
Fertilization	none
Water Quality	Observed some primary productivity
Harvest Method	Concentrating the fish on one corner of the cage then scooping

Remarks and Observations:

Control fish were lost a week after we had a video coverage in the site and approximately a month before the scheduled harvesting. at the farmer found a big hole on the cage that enable the fish to escape. Reason for these was unknown.

SMP-PMPC'S FARM

Location:	Pantabangan Reservoir, Pantabangan, Nueva Ecija
Culture unit:	Lake cages
Size of culture unit:	96 sq.m.
Stocking Density:	1,750 per pond
Stocking Date:	10 October, 1993
Harvest Date:	April 6, 1994
Days of culture:	178

ECONOMIC DATA

Inputs	Unit Price (P)	Amount (P)
Stocks 2,000 fingerlings	0.30	600.00
Cage rent	300.00	300.00
Feeds 10.5 bags of Robina feeds	267.62	2,810.00
Total Production Cost		3,710.00

* the same production cost for GMT and SRT

G M T	Amount (P)
Sales 275 kgs at P 42.00	11,550.00
Production cost	3,710.00
Net Profit	**7,840.00**

FAC\CLSU - UCS Genetic Manipulations for Improved Tilapia (GMIT)
Technology Adaptation and Development (TAD) Project

ON-FARM PERFORMANCE TRIALS OF GENETICALLY MALE TILAPIA (GMT)

FARM FACT FILE

Farm name:	**SMP-PMPC Farm - Second Trial**
Location:	Aya Dam, Pantabangan, Nueva, Ecija
Contact Person:	Mr. Led de la Cruz and Mr. Carlos Linsangan
Culture System:	Lake cage
Number of Culture Units:	Two (2)
Size of Culture Units (m^2):	96 m^2 or 192 m^3 (12m x 8m x 2m)
Stocking number\density:	2,000 @ 20.8/m^2 or @ 10.42/m^3.
Stocking date:	July 13, 1994
Harvest date:	November 25, 1994
Culture Period:	135 days
GMT Origin:	From production of April 1994
Control Origin:	Israel Strain produced by GMIT-TAD Project From production of April 1994
Growth Data File Name:	SMP-PMPC.WQ2
Economic Data File Name:	SMPPMPC2.EDF

Stocking Data:

	GMT	Control	% GMT difference	significance level
Mean SL (cm)	4.87	5.08	-4.13	ns
SD	0.77	0.70		
Mean Weight (g)	3.77	4.26	-11.50	ns
SD	1.80	2.05		
Sex Ratio (%Male)	100			

Management System Operated:

Water Source:	Aya Dam Reservoir
Feeding:	Irregular feeding with Robina commercial feeds
Fertilization	none
Water Quality	Observed some primary productivity
Harvest Method	Concentrating the fish on one corner of the cage then scooping
Remarks:	Harvested

Harvest Data:

	GMT	Control	% difference	significance
Number harvested	1,053.00	927.00	+13.59	
Survival (%)	52.63	46.34	+13.59	
Sex ratio (% male)	98.50	77.00	+27.92	
Mean SL (cm)	13.82	14.88	-07.12	
Mean Weight (g)	100.23	115.46	-13.19	
CV of weight	46.86	45.67	-02.60	
FCR	2.13	2.10	+01.43	
Biomass (kg)	105.5	107.00	-01.40	

Remarks and Observations:

The slightly better growth performance (individual weight and yield) of the control (MST) than the GMT in these particular trial was surprising especially as the GMT had a better survival rate. It was observed that the GMT population had plenty of blond type fish which was estimated to be around 60% of the population. The farmer noted that the blond type GMT fish doesn't grow as fast as the wild type GMT. The farmer was optimistic that the very low yield in the GMT population was due to the high percentage of Blond type fish in the population. The farmer added that it will be better if we could eliminate the blond type in the population.

Economic data (in Philippine Pesos):

Items	Qty (unit/m^2)	Unit Price	Amount (P/m^3/cropping)		Amount (P/m^3/day)	
			GMT	**MST**	**GMT**	**MST**
Fingerlings	10.42	0.30/pc	3.1250	3.1250	0.0231	0.0231
Feeds	1.17	12.00/kg	14.0625	14.0625	0.1042	0.1042
Cage Rent			1.5625	1.5625	0.0116	0.0116
Miscellaneous			n\a	n\a	n\a	n\a
Labor cost			1.1458	1.1458	0.0085	0.0085
Total Cost			**19.8958**	**19.8958**	**0.1474**	**0.1474**
Food Fish Sale	0.55	45.00/kg	24.7340	n/a	0.1831	n/a
Food Fish Sale	0.56	45.00/kg	n/a	25.0781	n/a	0.1858
Total Sales			24.7340	25.0781	**0.1831**	**0.1858**
Net Return			4.8281	5.1823	**0.0358**	**0.0384**

Summary:

Another cage trial completed.

SMP-PMPC CAGE PROJECT

Location:	Aya Dam, Pantabangan, Nueva Ecija
Culture unit:	Lake cages
Size of culture unit:	96 sq.m.(12m x 8m x 3m)
Stocking Density:	2,000 per cage ; @ 20.8 per sq.m.
Stocking Date:	July 13, 1994
Harvest Date:	November 25, 1994
Culture Period	135 days

ECONOMIC DATA

COST OF PRODUCTION		
Inputs		**Amount**
Stocks	2,000 pcs. at P 0.30/pc	600.00
Feeds	9 bags at P300.00/bag	2,700.00
Cage rent	P 300.00/cage	300.00
Labor		220.00
Total Production Cost		**3,820.00**

*Both for GMT and SRT

	GMT (P)		**MST (P)**
Sales		Sales	
105.5 kgs at P 45.00/kg	4 ,747.50	107.0 kgs at P 45.00/kg	4,815.00
Production Cost	3,820.00	Production Cost	3,820.00
Net Profit	**927.00**	**Net Profit**	**995.00**

ANNEX 4

TABLES SUMMARISING CULTURE CONDITIONS, PRODUCTION AND ECONOMIC DATA FROM ON-FARM TRIALS.

Table 1. Farm details and production data from on-farm trials in ponds.

Table 2. Farm details and production data for on-farm trials in cages.

Table 3. Farm details and production data from on-farm trials in rice-fish, polyculture and tank environments.

Table 4. Summary of production and sales costs for GMT and Control in on-farm trials in ponds.

Table 5. Summary of production and sales costs for GMT and controls in on-farm trials in cages.

Table 6. Summary of production and sales costs for GMT and Control in on-farm trials in rice-fish, polyculture and tank environments

Annex 4 - Table 1. Farm details and production data from on-farm trials in ponds.

Farm	Trt.	Area (m^2)[a]	Days of Culture	Stocking Density (pc/m^2)	# fish stocked	harvest weight (g)	Surv. (%)	Male (%)	CV of weight (%)	FCR	Yield (kg/cropping)	Yield ($kg/m^2/day$)	Remarks
PONDS													
MENDOZA	MST	350	289	5.00	1,750	81.2	28.4	65.6	34.2	n/a	40.4	0.0004	Completed
Bulacan	GMT	350	289	5.00	1,750	120.0	28.3	92.4	34.4	n/a	59.5	0.0006	
PSU	SRT	130	125	3.00	390	42.8	89.6	61.8	35.5	2.26	14.9	0.0009	Completed
Pangasinan	GMT	130	125	3.00	390	53.9	93.2	100.0	33.9	2.59	19.6	0.0012	
FELICIANO	SRT	1680	107	4.50	7,000	125.0	65.2	n/a	n/a	1.46	582.0	0.0032	Completed
Pampanga	GMT	1610	121	4.50	7,200	166.6	74.8	n/a	n/a	1.22	890.0	0.0046	
CRUZ	SRT	1700	192	7.00	12,000	102.0	52.0	51.2	25.2	0.77	679.0	0.0021	Completed
Nueva Ecija	GMT	1700	192	7.00	12,000	135.9	59.0	90.0	21.4	0.55	950.0	0.0029	
PAMINTUAN	SRT	1850	176	7.50	13,000	177.7	64.93	75.0	26.8	1.90	1500.0	0.0046	Completed
Pampanga	GMT	2000	176	7.50	15,000	130.6	91.86	94.0	21.4	2.08	1800.0	0.0051	
ABES	SRT	1536.5	145	2.90	4,500	113.7	74.27	46.8	23.0	n/a	380.0	0.0017	Completed
Nueva Ecija	GMT	1536.5	145	2.90	4,500	190.6	60.27	99.0	17.7	n/a	517.0	0.0023	
ABES-2	MST	1536.5		2.90	4,500								On-going
Nueva Ecija	GMT	1536.5		2.90	4,500								
CRSP	MST	500	135	2.0	1,000	101.1	73.9	n/a	19.8	n/a	69.3	0.0010	Completed
Nueva Ecija	GMT	500	135	2.00	1,000	122.4	87.1	n/a	26.3	n/a	98.8	0.0015	
MAN-VIE	MST	5000		2.00	10,000								Failed
Nueva Ecija	GMT	5000		2.00	10,000								
VILLASANA	MST	600		2.00	1,200								Failed
Isabela	GMT	600		2.00	1,200								
ROSARIO	MST	400		5.00	2,000								On-going
Nueva Ecija	GMT	400		5.00	2,000								

Table 1 Continued

Farm	Trt.	Area (m^2)[a]	Days of Culture	Stocking Density (pc/m^2)[b]	# fish stocked	harvest weight (g)	Surv. (%)	Male (%)	CV of weight (%)	FCR	Yield (kg/cropping)	Yield ($kg/m^2/day$)	Remarks
PONDS cont....													
PUYAT-2	SRT	300		5.00	1,500								On-going
Nueva Ecija	GMT	300		5.00	1,500								
NVSIT	MST	750		2.00	1,500								Failed
Nueva Viscaya	GMT	750		2.00	1,500								
MICU	MST	2000		5.00	10,000								Failed
Tarlac	GMT	2000		5.00	10,000								
MANUEL	MST	2000		5.00	10,000								Failed
Nueva Ecija	GMT	2000		5.00	10,000								
DAVA	MST	600		2.00	1,200								On-going
Laguna	GMT	600		2.00	1,200								
ASUNCION	MST	600		2.00	1,200								Failed
Nueva Ecija	GMT	600		2.00	1,200								
PAWAY	MST	90		2.20	200								Failed
Quirino	GMT	90		2.20	200								
Mean	**MST**	**425.0**	**212**	**3.50**	**1375**	**91.15**	**51.15**	**65.6**	**27.00**		**54.85**	**0.0007**	
	SRT	**1379.3**	**149**	**4.90**	**7378**	**112.24**	**69.20**	**58.7**	**27.60**	**1.59**	**631.18**	**0.0025**	
	Cont.	**1106.6**	**167**	**4.55**	**5663**	**106.21**	**64.04**	**60.08**	**27.42**	**1.59**	**466.51**	**0.0020**	
	GMT	**1118.1**	**169**	**4.55**	**5977**	**131.43**	**70.64**	**95.08**	**25.85**	**1.61**	**619.27**	**0.0026**	

Annex 4 - Table 1. Farm details and production data from on-farm trials in ponds.

Farm	Trt.	Area (m^2)[a]	Days of Culture	Stocking Density (pc/m^2)	# fish stocked	harvest weight (g)	Surv. (%)	Male (%)	CV of weight (%)	FCR	Yield (kg/cropping)	Yield ($kg/m^2/day$)	Remarks
PONDS													
MENDOZA	MST	350	289	5.00	1,750	81.2	28.4	65.6	34.2	n/a	40.4	0.0004	Completed
Bulacan	GMT	350	289	5.00	1,750	120.0	28.3	92.4	34.4	n/a	59.5	0.0006	
PSU	SRT	130	125	3.00	390	42.8	89.6	61.8	35.5	2.26	14.9	0.0009	Completed
Pangasinan	GMT	130	125	3.00	390	53.9	93.2	100.0	33.9	2.59	19.6	0.0012	
FELICIANO	SRT	1680	107	4.50	7,000	125.0	65.2	n/a	n/a	1.46	582.0	0.0032	Completed
Pampanga	GMT	1610	121	4.50	7,200	166.6	74.8	n/a	n/a	1.22	890.0	0.0046	
CRUZ	SRT	1700	192	7.00	12,000	102.0	52.0	51.2	25.2	0.77	679.0	0.0021	Completed
Nueva Ecija	GMT	1700	192	7.00	12,000	135.9	59.0	90.0	21.4	0.55	950.0	0.0029	
PAMINTUAN	SRT	1850	176	7.50	13,000	177.7	64.93	75.0	26.8	1.90	1500.0	0.0046	Completed
Pampanga	GMT	2000	176	7.50	15,000	130.6	91.86	94.0	21.4	2.08	1800.0	0.0051	
ABES	SRT	1536.5	145	2.90	4,500	113.7	74.27	46.8	23.0	n/a	380.0	0.0017	Completed
Nueva Ecija	GMT	1536.5	145	2.90	4,500	190.6	60.27	99.0	17.7	n/a	517.0	0.0023	
ABES-2	MST	1536.5		2.90	4,500								On-going
Nueva Ecija	GMT	1536.5		2.90	4,500								
CRSP	MST	500	135	2.0	1,000	101.1	73.9	n/a	19.8	n/a	69.3	0.0010	Completed
Nueva Ecija	GMT	500	135	2.00	1,000	122.4	87.1	n/a	26.3	n/a	98.8	0.0015	
MAN-VIE	MST	5000		2.00	10,000								Failed
Nueva Ecija	GMT	5000		2.00	10,000								
VILLASANA	MST	600		2.00	1,200								Failed
Isabela	GMT	600		2.00	1,200								
ROSARIO	MST	400		5.00	2,000								On-going
Nueva Ecija	GMT	400		5.00	2,000								

Table 1 Continued

Farm	Trt.	Area (m^2)[a]	Days of Culture	Stocking Density (pc/m^2)[b]	# fish stocked	harvest weight (g)	Surv. (%)	Male (%)	CV of weight (%)	FCR	Yield (kg/cropping)	Yield ($kg/m^2/day$)	Remarks
PONDS cont....													
PUYAT-2	SRT	300		5.00	1,500								On-going
Nueva Ecija	GMT	300		5.00	1,500								
NVSIT	MST	750		2.00	1,500								Failed
Nueva Viscaya	GMT	750		2.00	1,500								
MICU	MST	2000		5.00	10,000								Failed
Tarlac	GMT	2000		5.00	10,000								
MANUEL	MST	2000		5.00	10,000								Failed
Nueva Ecija	GMT	2000		5.00	10,000								
DAVA	MST	600		2.00	1,200								On-going
Laguna	GMT	600		2.00	1,200								
ASUNCION	MST	600		2.00	1,200								Failed
Nueva Ecija	GMT	600		2.00	1,200								
PAWAY	MST	90		2.20	200								Failed
Quirino	GMT	90		2.20	200								
Mean	**MST**	**425.0**	**212**	**3.50**	**1375**	**91.15**	**51.15**	**65.6**	**27.00**		**54.85**	**0.0007**	
	SRT	**1379.3**	**149**	**4.90**	**7378**	**112.24**	**69.20**	**58.7**	**27.60**	**1.59**	**631.18**	**0.0025**	
	Cont.	**1106.6**	**167**	**4.55**	**5663**	**106.21**	**64.04**	**60.08**	**27.42**	**1.59**	**466.51**	**0.0020**	
	GMT	**1118.1**	**169**	**4.55**	**5977**	**131.43**	**70.64**	**95.08**	**25.85**	**1.61**	**619.27**	**0.0026**	

Annex 4 - Table 2. Farm details and production data for on-farm trials in <u>cages.</u>

Farm	Trt.	Area (m^3)	Days of Culture	Stocking Density (pc/m^3)	# fish stocked	harvest weight (g)	Surv. (%)	Male (%)	CV of weight (%)	FCR	Yield (kg/cropping)	Yield ($kg/m^3/day$)	Remarks
CAGES													
MFI	MST	120	68	25.00	3,000	57.0	60.5	71.4	46.8	1.62	103.5	0.0127	Completed
Batangas	GMT	120	68	25.00	3,000	100.4	60.4	96.3	41.3	1.38	180.0	0.0221	
CAMPÇI	MST	168	170	3.47	1,000	108.0	69.0	45.0	45.8	1.68	74.5	0.0026	Completed
Ma. Aurora	GMT	168	170	3.47	1,000	153.3	58.7	97.0	40.7	1.39	90.0	0.0032	
SIBUL	MST	288	151	6.94	2,000	93.2	39.1	55.0	29.7	n/a	109.4	0.0025	Completed
Nueva, Ecija	GMT	288	151	6.94	2,000	125.7	40.6	92.0	23.5	n/a	153.2	0.0035	
OBUNGEN	MST	360		8.33	3,000								Failed
Isabela	GMT	360		8.33	3,000								
OBUNGEN-2	MST	360	163	8.33	3,000	308.3	52.5	86.5	31.8	3.81	485.0	0.0083	Completed
Isabela	GMT	360	163	8.33	3,000	288.3	76.5	100.0	37.9	2.80	661.0	0.0113	
SMP-PMPC	MST	192		10.42	2,000								Failed
Nueva Ecija	GMT	192		10.42	2,000								
SMP-PMPC-2	MST	192	135	10.42	2,000	115.46	46.34	77.0	45.7	2.10	107.0	0.0041	Completed
Nueva Ecija	GMT	192	135	10.42	2,000	100.23	52.63	98.5	46.9	2.13	105.5	0.0041	
BONDAD	SRT	400	90	11.25	4,500	163.4	79.8	98.3	32.7	1.98	632.0	0.0176	Completed
Batangas	GMT	400	90	11.25	4,500	215.3	82.2	99.0	28.5	1.88	665.0	0.0185	
TRINOS	MST	360		8.33	3,000								Failed
Nueva Viscaya	GMT	360		8.33	3,000								
Mean	MST	225.6	137.4	10.83	2200	136.39	53.48	67.0	39.95	2.30	175.88	0.006	
	SRT	400.0	90	11.25	4500	163.4	79.80	98.3	32.70	1.98	632.00	0.018	
	Cont.	254.7	129.5	10.90	2584	140.89	57.87	72.2	38.75	2.24	251.90	0.008	
	GMT	254.7	129.5	10.90	2584	163.87	61.84	97.1	36.46	1.91	309.11	0.010	

Annex 4 - Table 3. Farm details and production data from on-farm trials in, rice-fish, polyculture and tank environments.

Farm	Trt.	Area (m^2)[a]	Days of Culture	Stocking Density (pc/m^2)	# fish stocked	harvest weight (g)	Surv. (%)	Male (%)	CV of weight (%)	FCR	Yield (kg/cropping)	Yield ($kg/m^2/day$)	Remarks
Rice fish													
DA-IRRI	MST	558	124	0.50	279	33.6	61.6	47.1	31.4	n/a	5.8	0.00008	Completed
Nueva Ecija	GMT	558	124	0.50	279	49.3	69.9	93.3	21.3	n/a	9.6	0.00014	
Polyculture													
CRSP-2	MST	500	135	2.00	1,000	121.66	73.0	n/a	20.3	n/a	83.0	0.0012	Completed
	catfish			0.30	150	101.70	78.0				11.9	0.00017	
Nueva Ecija	GMT	500	135	2.00	1,000	119.29	96.3	n/a	13.6	n/a	102.5	0.0015	Completed
	catfish			0.30	150	150.90	70.7				16.0	0.00024	
Tank													
SMFI	SRT	200	130	3.55	710	168.0	90.4	97.8	24.8	1.72	107.8	0.0041	Completed
Negros Occ.	GMT	200	124	3.55	710	215.4	100.0	99.2	23.9	1.62	156.3	0.0063	
PUYAT	SRT	300	102	5.0	1,500	175.6	89.6	100.0	n/a	1.64	227.0	0.0074	Completed
Nueva Ecija	GMT	300	102	5.0	1,500	145.2	95.8	100.0	n/a	1.44	258.0	0.0084	
MFI-2	MST	10	111	5.0	50	104.4	76.0	60.5	32.0	1.95	3.9	0.0035	Completed
Rizal	SRT	10	111	5.0	50	108.2	74.0	94.6	28.9	1.93	4.0	0.0036	
	GMT	10	111	5.0	50	114.9	82.0	97.5	22.7	1.64	4.7	0.0042	
Mean (tank)	**MST**	**10**	**111**	**5.0**	**50**	**104.4**	**76.00**	**60.5**	**32.00**	**1.95**	**3.90**	**0.0035**	
	SRT	**170**	**114**	**4.5**	**753**	**150.6**	**84.66**	**97.4**	**26.85**	**1.76**	**112.93**	**0.0050**	
	Cont.	**130**	**113**	**4.6**	**577**	**139.0**	**82.49**	**88.2**	**28.14**	**1.81**	**85.67**	**0.0046**	
	GMT	**170**	**112**	**4.5**	**753**	**158.5**	**92.93**	**98.9**	**23.30**	**1.56**	**139.93**	**0.0063**	

Annex 4 - Table 4. Summary of production and sales costs and returns for GMT and Control in on-farm trials <u>in ponds</u>.

	TRT	Production Cost (P/m^2/day)[a]								Sales (P/m^2/day)[a]	Net Returns (P/m^2/day)[a]
		Fingerling	Feeds	Fertilizer	Fuel/ electricity	Cage rent	Misc.	Labor Cost	TOTAL		
PONDS											
MENDOZA	MST	0.35	n\a	0.71	n\a	n\a	n\a	0.51	1.57	1.60	0.03
Bulacan	GMT	0.35	n\a	0.71	n\a	n\a	n\a	0.51	1.57	2.35	0.78
PSU	SRT	0.49	1.89	2.05	0.41	n\a	0.77	2.88	8.49	8.89	0.40
Pangasinan	GMT	0.49	2.80	2.05	0.41	n\a	0.77	2.88	9.40	12.11	2.70
FELICIANO	SRT	1.99	5.63	n\a	n\a	n\a	0.56	0.31	8.48	14.49	6.00
Pampanga	GMT	1.99	6.49	n\a	n\a	n\a	0.51	0.28	9.12	20.59	11.47
CRUZ	SRT	1.29	1.46	0.65	0.27	n\a	n\a	2.76	6.42	9.60	3.18
Nueva Ecija	GMT	1.29	1.46	0.65	0.27	n\a	n\a	2.76	6.42	14.55	8.13
PAMINTUAN	SRT	1.20	10.22	0.10	2.46	n\a	1.60	2.05	17.62	20.73	3.11
Pampanga	GMT	1.28	10.62	0.09	2.27	n\a	1.62	1.89	17.83	21.88	4.05
ABES	SRT	0.61	0.88	n\a	0.70	n\a	4.04	0.65	6.87	9.21	2.34
Nueva Ecija	GMT	0.61	0.88	n\a	0.70	n\a	4.04	0.65	6.87	12.53	5.66
CRSP	SRT	0.44	n\a	0.86	n\a	n\a	0.74	0.68	2.73	4.62	1.89
Nueva Ecija	GMT	0.44	n\a	0.86	n\a	n\a	0.74	0.68	2.73	6.59	3.86
Mean	**MST**	**0.35**	**n\a**	**0.71**	**n\a**		**n\a**	**0.51**	**1.57**	**1.60**	**0.03**
	SRT	**1.00**	**4.02**	**0.92**	**0.96**		**1.54**	**1.56**	**8.44**	**11.26**	**3.42**
	Contl	**0.91**	**4.02**	**0.87**	**0.96**		**1.54**	**1.41**	**7.45**	**9.88**	**2.94**
	GMT	**0.92**	**4.02**	**0.87**	**0.91**		**1.54**	**1.38**	7.71	**12.94**	**5.24**

Annex 4 - Table 6. Summary of costs and returns for GMT and Control in on-farm trials in rice-fish, polyculture and tank environments

	TRT	Production Cost ($P/m^2/day$)[a]								Sales ($P/m^2/day$)[a]	Net Returns ($P/m^2/day$)[a]
		Fingerling	Feeds	Fertilizer	Fuel/ electricity	Cage rent	Misc.	Labor Cost	TOTAL		
Rice fish											
DA-IRRI	MST	0.09	0.03	0.01	n\a	n\a	0.02	0.07	0.22	0.25	0.03
Nueva Ecija	GMT	0.09	0.03	0.01	n\a	n\a	0.02	0.07	0.22	0.42	0.20
Polyculture											
CRSP-2	MST	0.44	n\a	0.86	n\a	n\a	0.44	0.68	2.66	5.53	3.94
	catfish	0.22	n\a		n\a	n\a				1.06	
Nueva Ecija	GMT	0.44	n\a	0.86	n\a	n\a	0.44	0.68	2.66	6.83	5.60
	catfish	0.22	n\a		n\a	n\a				1.42	
Tank											
SMFI	SRT	0.55	8.91	n\a	3.72	n\a	1.38	2.50	17.05	18.67	1.61
Negros Occ.	GMT	0.57	12.81	n\a	3.72	n\a	1.44	2.50	21.30	28.36	7.06
PUYAT	SRT	0.98	58.20	n\a	4.90	n\a	1.63	1.67	24.38	33.38	9.50
Nueva Ecija	GMT	0.98	58.20	n\a	4.90	n\a	1.63	1.67	24.38	37.94	13.56
MFI-2	MST	0.90	8.03	n\a	2.50	n\a	0.90	1.80	14.13	16.05	1.96
Rizal	SRT	0.90	8.03	n\a	2.50	n\a	0.90	1.80	14.13	16.22	2.08
	GMT	0.90	8.03	n\a	2.50	n\a	0.90	1.80	14.13	19.05	4.92
Mean	MST	0.90	8.03	n\a	2.50	n\a	0.90	1.80	14.13	16.05	1.96
	SRT	0.81	25.05	n\a	3.71	n\a	1.30	1.99	18.52	22.76	4.40
	Contl	0.83	20.79	n\a	3.40	n\a	1.20	1.94	17.42	21.08	3.78
	GMT	0.81	26.35	n\a	3.71	n\a	1.32	1.99	19.94	28.45	8.51

Annex 4 - Table 4. Summary of production and sales costs and returns for GMT and Control in on-farm trials <u>in ponds</u>.

	TRT	Production Cost (P/m²/day)[a]								Sales (P/m²/day)[a]	Net Returns (P/m²/day)[a]
		Fingerling	Feeds	Fertilizer	Fuel/ electricity	Cage rent	Misc.	Labor Cost	TOTAL		
PONDS											
MENDOZA	MST	0.35	n\a	0.71	n\a	n\a	n\a	0.51	1.57	1.60	0.03
Bulacan	GMT	0.35	n\a	0.71	n\a	n\a	n\a	0.51	1.57	2.35	0.78
PSU	SRT	0.49	1.89	2.05	0.41	n\a	0.77	2.88	8.49	8.89	0.40
Pangasinan	GMT	0.49	2.80	2.05	0.41	n\a	0.77	2.88	9.40	12.11	2.70
FELICIANO	SRT	1.99	5.63	n\a	n\a	n\a	0.56	0.31	8.48	14.49	6.00
Pampanga	GMT	1.99	6.49	n\a	n\a	n\a	0.51	0.28	9.12	20.59	11.47
CRUZ	SRT	1.29	1.46	0.65	0.27	n\a	n\a	2.76	6.42	9.60	3.18
Nueva Ecija	GMT	1.29	1.46	0.65	0.27	n\a	n\a	2.76	6.42	14.55	8.13
PAMINTUAN	SRT	1.20	10.22	0.10	2.46	n\a	1.60	2.05	17.62	20.73	3.11
Pampanga	GMT	1.28	10.62	0.09	2.27	n\a	1.62	1.89	17.83	21.88	4.05
ABES	SRT	0.61	0.88	n\a	0.70	n\a	4.04	0.65	6.87	9.21	2.34
Nueva Ecija	GMT	0.61	0.88	n\a	0.70	n\a	4.04	0.65	6.87	12.53	5.66
CRSP	SRT	0.44	n\a	0.86	n\a	n\a	0.74	0.68	2.73	4.62	1.89
Nueva Ecija	GMT	0.44	n\a	0.86	n\a	n\a	0.74	0.68	2.73	6.59	3.86
Mean	**MST**	**0.35**	n\a	**0.71**	**n\a**		**n\a**	**0.51**	**1.57**	**1.60**	**0.03**
	SRT	**1.00**	**4.02**	**0.92**	**0.96**		**1.54**	**1.56**	**8.44**	**11.26**	**3.42**
	Contl	**0.91**	**4.02**	**0.87**	**0.96**		**1.54**	**1.41**	**7.45**	**9.88**	**2.94**
	GMT	**0.92**	**4.02**	**0.87**	**0.91**		**1.54**	**1.38**	**7.71**	**12.94**	**5.24**

Annex 4 - Table 6. Summary of costs and returns for GMT and Control in on-farm trials in rice-fish, polyculture and tank environments

	TRT	Production Cost (P/m²/day)[a]								Sales (P/m²/day)[a]	Net Returns (P/m²/day)[a]
		Fingerling	Feeds	Fertilizer	Fuel/ electricity	Cage rent	Misc.	Labor Cost	TOTAL		
Rice fish											
DA-IRRI	MST	0.09	0.03	0.01	n\a	n\a	0.02	0.07	0.22	0.25	0.03
Nueva Ecija	GMT	0.09	0.03	0.01	n\a	n\a	0.02	0.07	0.22	0.42	0.20
Polyculture											
CRSP-2	MST	0.44	n\a	0.86	n\a	n\a	0.44	0.68	2.66	5.53	3.94
	catfish	0.22	n\a		n\a	n\a				1.06	
Nueva Ecija	GMT	0.44	n\a	0.86	n\a	n\a	0.44	0.68	2.66	6.83	5.60
	catfish	0.22	n\a		n\a	n\a				1.42	
Tank											
SMFI	SRT	0.55	8.91	n\a	3.72	n\a	1.38	2.50	17.05	18.67	1.61
Negros Occ.	GMT	0.57	12.81	n\a	3.72	n\a	1.44	2.50	21.30	28.36	7.06
PUYAT	SRT	0.98	58.20	n\a	4.90	n\a	1.63	1.67	24.38	33.38	9.50
Nueva Ecija	GMT	0.98	58.20	n\a	4.90	n\a	1.63	1.67	24.38	37.94	13.56
MFI-2	MST	0.90	8.03	n\a	2.50	n\a	0.90	1.80	14.13	16.05	1.96
Rizal	SRT	0.90	8.03	n\a	2.50	n\a	0.90	1.80	14.13	16.22	2.08
	GMT	0.90	8.03	n\a	2.50	n\a	0.90	1.80	14.13	19.05	4.92
Mean	MST	0.90	8.03	n\a	2.50	n\a	0.90	1.80	14.13	16.05	1.96
	SRT	0.81	25.05	n\a	3.71	n\a	1.30	1.99	18.52	22.76	4.40
	Contl	0.83	20.79	n\a	3.40	n\a	1.20	1.94	17.42	21.08	3.78
	GMT	0.81	26.35	n\a	3.71	n\a	1.32	1.99	19.94	28.45	8.51