74 YEARS OF TILAPIA CULTURE AND DEVELOPMENT IN INDONESIA
(1936 – 2010)

By

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Content

Tilapia Culture and Development in Indonesia (1936 – 2010)

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1. Overview of tilapia worldwide

Tilapia have become a shining star of aquaculture with farms starting and expanding across the globe, while consumption races ahead of even the most ambitious farm building plans. In 2010, farmed tilapia exceed 3.2 million metric tons per annum, surging further ahead of the salmon and catfish industries (Fitzsimmons, 2011). The global adoption of tilapia as a substitute for all kinds of wild-caught fish has driven demand higher every year, even though there has been a global recession in recent years. The description of tilapia as an "aquatic chicken" becomes more accurate every day. The wide acceptance of this fish across all cultural, religious, and economic groups is similar to chicken. A variety of breeds and strains have been developed and by most measures, tilapia are now the most highly domesticated of farmed fish species. Unique among the major farmed fishes, tilapia maintain a key role in rural aquaculture improving the welfare of the poorest farmers, while at the same time, they are reared in the most high tech production systems and are sold into up-scale international markets. Tilapia are still the darling of the environmental community and the industry continues to polish and promote its "green" credentials.

Tilapia continue to march towards eventually overtaking carp as the most important farmed fish crop. With a much wider distribution of production and consumption and a huge base of value added product forms, this fish will someday, most likely, eclipse carp production. As production and consumption grow globally, tilapia are likely to become the foundation product for all farmed fishes, just as chicken is the base for the poultry industry. So someday soon instead of referring to tilapia as the aquatic chicken we may be referring to chicken as the "terrestrial tilapia".

In terms of geographic distribution, FAO reports tilapia production from over 100 nations (FAO, 2010). This vast base of production and interest in the fish vastly exceeds any other farmed fish. The consumer demand is equally widespread. There are no reports of cultural or religious restrictions on consuming tilapia, contrasted to other terrestrial animal products such as beef and pork and bottom dweller aquatic species.

The major countries in tilapia production harvested just over 3,200,000 metric tons of in 2010 (FAO, 2010) (Figure 2. 1). China continues to be the main tilapia producer in the world, with Egypt, Indonesia, the Philippines and Thailand increasing production every year. As one of the main tilapia producers in the world, unfortunately, literature on tilapia culture in Indonesia is limited. Therefore, this chapter reviews the history of tilapia culture and development in Indonesia, which was started in 1930's.

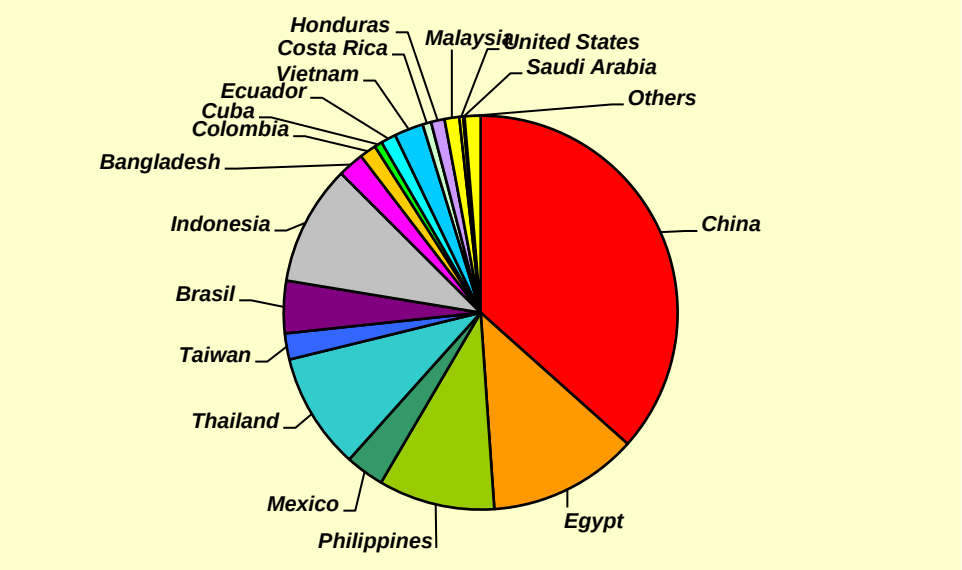


Figure 1. World tilapia production in 2010

2. Tilapia in Indonesia

In Indonesia, tilapia are known as ‘ikan nila’ (for *Oreochromis niloticus*) and ‘ikan mujair’ (for *O. mossambicus*). Not native to Indonesia, the local name ‘mujair’ for *O. mossambicus* came from the person who found this fish in 1936 in the Serang River, Blitar, East Java. The most likely explanation for the appearance of this non-native fish was that the Dutch, during the colonial era, shipped live fish from its native habitat in Africa to Indonesia. Both South Africa and Indonesia were colonized by the Dutch during the same period. Shelton and Popma (2006) speculated the introduction from aquarium trade. Nevertheless, this history also explains how the common name for Mossambique Tilapia at some point became Java Tilapia, as it was already found in Java, one of the islands in Indonesia in 1930’s (Bardach and Ryther, 1972; Shelton and Popma, 2006). During the Japanese occupation in Indonesia (1942 – 1945), the Japanese spread the fish to other occupied territories, mostly in Asia, and people called the fish as Java Tilapia. Based on the

identification by taxonomists, later it was determined that what had been famous as Java Tilapia, was in fact the Mossambique Tilapia (Shelton and Popma, 2006).

The fish was first regarded as nuisance, but when facilities for milkfish culture began deteriorated under the Japanese occupation, the easiness culture of tilapia became apparent. By the end of the Second World War, tilapia were already found in many places in Indonesia (Bardach and Ryther, 1972).

The development of tilapia culture in Indonesia was quite rapid. In the beginning, tilapia farming concentrated on optimizing the technique/method for cultivation, including the fingerling supply to increase production. However, the genetic improvement program lagged behind production. Starting in the late 1960's, an effort to improve the genetic quality, through importation of improved strains, especially Nile Tilapia, was conducted. Since then, several strains from other geographic locations have been introduced into Indonesia.

3. Moedjair, the Mossambique Tilapia Aquaculture Pioneer from Indonesia

The history of tilapia in Indonesia was started by single man, Moedjair (old Indonesian spelling), or Mujair (modern spelling). For consistency, this chapter will use the old spelling when referring to his name, and the new spelling for the name of the fish which was derived from his name.

Based on personal communications with the remaining family members, his real name was Iwan Dalauk, but he was better known as Moedjair. He was born in 1890, in a village 3 miles east of Kuningan in Blitar, one of the regions in East Java. He was the promoter for *Oreochromis mossambicus* in Indonesia. Born into a family with nine children, his father was Bayan Isman and

his mother was Rubiyah. Later in life, he married Partimah, a daughter of an Islamic cleric in the village. Together, they had seven children. Out of these seven, by 2012, only two children are left, Ismoenir who continues to live in Kanigoro, Blitar, and Djaenuri who lives in Kencong, Jember. The interview was conducted with the family in Blitar.

During his life, Moedjair was selling goat satay (an Indonesian traditional food, a kind of grilled goat). His restaurant was quite famous in those days in Kanigoro. Customers came from different ethnic groups, including the Dutch, the Arabs, and the Chinese. As a result, soon he became a rich man. Unfortunately, he had one bad habit. Since he had a lot of money, he started gambling. Moedjair did not gamble with Indonesian natives, only amongst the rich Chinese people and he did not allow his children to gamble. Moedjair was not good at gambling and soon he went into bankruptcy.

During this hard time in his life, Moedjair travelled and contemplated on a special day, at a special place close to Serang River in Blitar. He did traditional ritual bathing to cleanse himself from the bad things he had done in the past. At one point during the ritual bath, he saw a number of fish. He thought the fish was so unique. The fish carried the babies in their mouths when they were in danger and then released them in safer situations.

Because of this unusual mouth breeding behavior, which he had never seen before, together with his two friends (Abdulah Iskak and Umar), Moedjair brought the fish back to his home in Papungan village in Kanigoro, Blitar. Due to different habitats, the fish died when he put them into freshwater. This drove his curiosity to culture the fish in freshwater environment. In fact, the distance from his village to the river was quite long (about 35 kilometer), and passed the jungle and hills. Difficult road access made the trip take two days and two nights in total.

When he saw similar fish again, he mixed seawater and freshwater. He continued mixing the water by decreasing the amount of seawater and increasing the freshwater overtime. After eleven generations, he was able to successfully keep four fish without seawater. Starting from that day, the fish were known as freshwater fish in the area. Moedjair recorded this achievement on March 25, 1936.

Moedjair was very satisfied with his experiment. He started to culture the fish in one pond and later three ponds. Moedjair found that the fish grew very rapidly. He shared his fish for free with residents in his village and sold them in other places in Blitar.

The discovery of this new species of fish came to the attention of a Dutch officer who was based in in Kediri, East Java. The officer was a scientist and he tried to identify the fish based on the literature. He interviewed Moedjair and he was impressed by this traditional farmer's accomplishment. As the Dutch authority for the area, he announced that he named the fish as mujair, to honor the founder. Later, by taxonomy, it was identified that the fish was the Mossambique Tilapia (Shelton and Popma, 2006).

Again, Moedjair became popular, not as a goat satay restaurant owner, but as a fisherman. After the Indonesian independence in 1945, with the help of his eldest son, Wahanan, he marketed the fish to almost the entire mainland of East Java. By the local government, he was appointed as one officer in Papungan Village and received a monthly salary. The new Indonesian government appointed him as a fisheries extension specialist.

Several recognitions were awarded to Moedjair. The first one was during the Indonesian independence day celebration, on August 17, 1951. The Minister of Agriculture (Soewarto), on behalf of the Government of Indonesia, gave the citizenship award to him. The second award was from the Executive Committee of the Indonesian Fisheries Council for finding the mujair fish. This award was given in Bogor, West Java, on June 30, 1954.

Soon, Moedjair was recognized as a tilapia expert. He made different ponds in East Java. Many people visited him to gain knowledge on fisheries. During his elderly time and as his health declined, Moedjair started three ponds in Krajan Village. He passed away September 1, 1957 because of asthma and he was buried in the cemetery in Papungan village. In 1960, upon the initiative of the Department of Fisheries of Indonesia, his tomb was moved to the area south of the village which also serves as the family tomb. In recognition of his service, his tombstone reads: "Moedjair, the founder of Moedjair Fish". The road to the cemetery was also named Moedjair Street to honor him.

On April 6, 1965, the Indonesian Government, through the Department of Fisheries and Marine Affairs, recognized him as the aquaculture pioneer in Indonesia.

All pictures presented in this chapter regarding Moedjair were obtained from his family.

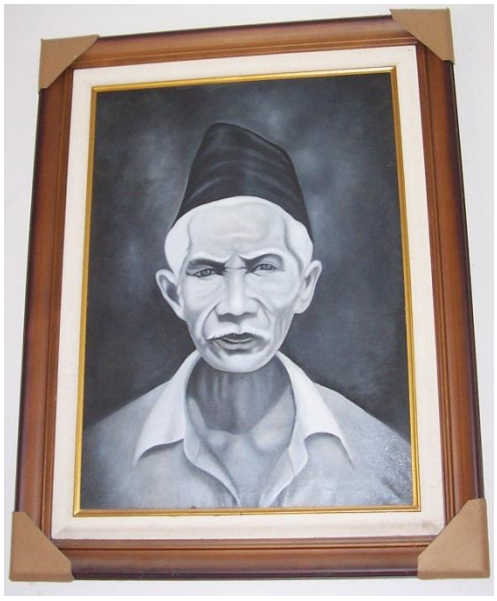
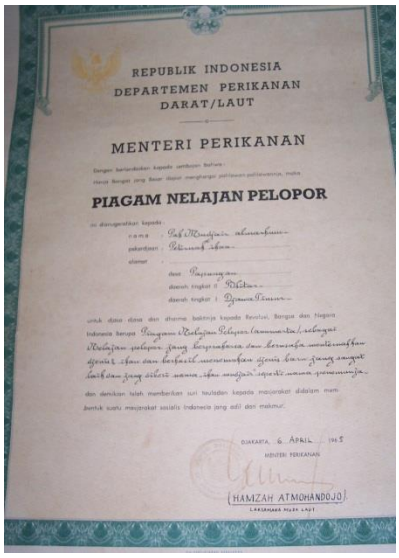


Figure 2. Portrait sketch of Moedjair (Photo by Dodit Ari G.)

Figure 3. The tombstones of Moedjair (right) with the fish relief and his wife (left). Photo by Ating Yuniarti

Figure 4. The Mujair Street in Blitar, East Java. Photo by A. Yuniarti



REPUBLIK INDONESIA
DEPARTEMEN PERIKANAN
DARAT/LAUT

MENTERI PERIKANAN

PIAGAM NELAJAN PELOPOR

HAMZAH ATMOHANDOJO

Figure 5. Aquaculture Pioneer recognition award, given by the Indonesian Minister of Fisheries in 1965. Photo by Dodit Ari G.

4. The Nile Tilapia

The Nile Tilapia was introduced from Taiwan in 1969, followed by a special black colored tilapia, the Chitralada, from Thailand in 1989, and GIFT (Genetic Improvement of Farmed Tilapia) from the Philippines in 1994. Another strain, NIFI (Thai Red Tilapia Strain), was first imported from Thailand in 1989.

After six generations, in 1997, GIFT tilapia, which was the main tilapia strain in Indonesia at that time, experienced a decrease in the genetic quality because of reproduction management which was not accurate and therefore influenced growth. As a result, the decrease in production was unavoidable. This encouraged the formation of the National Tilapia Broodstock Development Center in Sukabumi, West Java. By gathering fish genetic experts, the center was expected to develop several new superior strains of tilapia from the genetic resources existing in Indonesia.

In 2002-2004, a Freshwater Research Centre in Jambi, Sumatra, under the Indonesian Ministry of Marine Affairs and Fisheries (MMAF) developed JICA (Japan for International Cooperation Agency) Nile Tilapia, which was originally from Kagoshima Fisheries Research Station in Japan. JICA Tilapia development was fully funded by the JICA, therefore the strain's name indicates the donor. Based on MMAF report, the JICA strain grows faster, produces more eggs (better fecundity), and reduce the feed cost up to 25% compared to the GIFT strain (MMAF, 2005).

In 2006, the Agency for the Assessment and Application of Technology, an Indonesian government research body, introduced a new strain named "Genetically Supermale Indonesian Tilapia" (GESIT). GESIT are genetically manipulated to hatch eggs that will produce 98% - 100%

male tilapia (this paper). This will benefit fish farmers to culture all male tilapia which grow faster compared to mixed sexes as females spends energy for reproduction.

There have been many other improved strains produced, such as Nirwana from Wanayasa (West Java) in 2006, Umbuwan from East Java (2008), and BEST (Bogor Enhanced Strain Tilapia) from Bogor in 2009. The development of GESIT strain will be discussed in more detail in the next section following the review of production data (MMAF, 2010).

5. Tilapia Production and Market

Tilapia have become popular with local fish farmers because they are easy to farm and grow fast. Major tilapia production areas are in West Java and North Sumatra, where Regal Springs, has one of its operations. Regal Springs Tilapia, the world's largest aquafarmer of tilapia, discovered two decades ago that Indonesia was favorable for farming the affordable whitefish so popular with Americans. In a rural landscape of volcanoes, rice fields and fresh water springs in Central Java, Regal Springs began farming tilapia in 1988 after Regal's founder had previously worked with the United Nations Food and Agriculture Organization in West Java.

In 2004, the national production of tilapia was 97.116 MT and increased by 500% in six years to 464,191 MT in 2010 for Nile Tilapia only as statistic for other tilapia is not available (MMAF, 2011). This figure means that the production increased significantly in four years, despite the global economic crisis in 2008. Most of this production is dedicated to domestic demand, and not the export market. Based on FAO Fish Report (2008), Indonesia is among the five top cultured fish producers, but its export growth is not even in the top ten. Based on MMAF predictions (2011), there are about 14 million hectares of river streams and lakes that can be used for freshwater

aquaculture development in Indonesia. Currently, only 10.1% are being used for tilapia and other fish culture.

Table 1 outlined the top eight aquaculture major commodities in Indonesia including tilapia and shrimp. Compared to other species, both tilapia and catfish show promising trends in terms of production. With the emergence of KHV (Koi Herpes Virus) disease in carp, tilapia became an alternative freshwater fish, and one of the major commodities in the Indonesian Aquaculture Revitalization program for the following reasons: (1) high economic value, (2) culture technology is available and widely known to public, (3) high demand in export and domestic markets, and (4) can be massively cultured and developed.

Table 1. Major aquaculture production in Indonesia from 2003 – 2010 (in MT)

Species	2003	2004	2005	2006	2007	2008	2009	2010	% increase (2003-2010)
Shrimp	192,912	238,854	280,629	327,610	358,925	409,590	338,060	380,972	97
Nile Tilapia	**71,947**	**97,116**	**148,249**	**169,390**	**206,904**	**291,037**	**323,389**	**464,191**	**545**
Milkfish	227,854	241,438	254,067	212,883	263,139	277,471	328,288	421,757	85
Common Carp	219,385	192,462	216,920	247,633	264,349	242,322	249,279	282,695	29
Clarias (catfish)	58,614	51,271	69,386	77,272	91,735	114,371	144,755	242,811	314
Pangasius (catfish)	12,904	23,962	32,575	31,490	36,755	102,021	109,685	147,888	1046

Giant gouramy	22,666	23,758	25,442	28,710	35,708	36,636	46,254	56,889	151
Tilapia rank	4	4	4	5	6	2	3	2	

Note : excluding seaweed production. Source: MMAF statistics (2011)

In Subang, West Java, farmers culture the Nile Tilapia in running water ponds. After 6-7 months, the weight reached 700 grams, a minimum for fillet fish production. Tilapia are also cultured in floating cages in Indonesia, particularly when the location is an open lake, or open brackish water with fish density usually around 10 fish per square meter. During the harvest time, the farmers pull out the floating cage or floating net to collect the fish. Typical harvest per 1,000 square meter and 1.5 meter depth is 7 metric tons of whole fish or equal to 2.8 metric tons of fillet fish (personal observation and interview to farmers).

Tilapia culture in Indonesia shows promising trends, with West Java being the top producer for many years. Based on MMAF predictions, there are about 14 million hectares of river streams and lakes that can be used for freshwater aquaculture development, and currently, only 10.1% are being used for tilapia and other fish culture (MMAF, 2010). Table 2.1 describes the top ten producers for Nile Tilapia in Indonesia from 2005-2009. The significant increase for North Sumatera in 2008 came from Regal Springs Tilapia operation in Toba Lake. Similarly, West Sumatera also shows increased production as they utilize Maninjau Lake. Different from other locations, tilapia are cultured in brackish water in Central Java. The production in Banjar and Tabalong in Indonesia suggests that tilapia culture could be a promising alternative livelihood for coastal communities. All other locations in Indonesia show increasing production trend.

Table 2. Top ten producers for Nile Tilapia in Indonesia (in Metric Tons)

No	Province	Year				
		2005	2006	2007	2008	2009
1	West Java	48,069	76,163	85,954	100,454	87,397
2	South Sumatera	18,617	24,980	28,783	40,154	48,991
3	North Sumatera	1,465	1,210	3,435	36,290	39,614
4	West Sumatera	20,661	14,498	18,791	31,963	30,847
5	Central Java	9,860	11,686	12,362	14,095	20,073
6	South Kalimantan	2,936	5,130	3,750	4,815	19,637
7	North Sulawesi	9,557	4,445	10,476	10,831	11,123
8	Jambi	4,891	4,857	6,695	7,874	9,848
9	East Java	6,027	6,182	6,981	7,660	8,521
10	Bengkulu	2,668	2,732	4,191	5,738	7,134

Source: Ministry of Marine Affairs and Fisheries/MMAF (2010)

The total production for both species (Nile Tilapia and Mossambique Tilapia) was 328,831 MT in 2008. Table 2.2 shows the detail production for each main island and province. For Nile Tilapia only, in 2009, the total production increased by 11.12% in one year (from 291,037 MT to 323,389 MT).

Table 3. Total Production of Tilapia in Indonesia for the year 2008 (in metric tons)

Province	*O. niloticus*	*O. mossambicus*
SUMATERA	135,776	7,972
Nanggroe Aceh Darusalam	3,650	1,860
North Sumatera	36,290	1,120
West Sumatera	31,963	2,407
R i a u	5,290	-
Riau Islands	23	1
J a m b i	7,874	21
South Sumatera	40,154	1 659
Bangka Belitung	325	1

Bengkulu	5,738	773
Lampung	4,471	130
J A V A	127,224	26,553
DKI Jakarta	578	228
Banten	1,521	2,986
West Java	100,454	12,492
Central Java	14,095	2,672
D.I. Yogyakarta	2,915	21
East Jawa	7,660	8,153
BALI-NUSATENGGARA	2,709	252
B a l i	364	4
West Nusa Tenggara	2,122	224
East Nusa Tenggara	222	24
KALIMANTAN	10,558	35
West Kalimantan	844	-
Central Kalimantan	1,601	-
South Kalimantan	4,815	-
East Kalimantan	3,298	35
SULAWESI	13,392	2,876
North Sulawesi	10,831	590
Gorontalo	1,422	-
Central Sulawesi	557	3
West Sulawesi	40	22
South Sulawesi	405	2 136
Southeast Sulawesi	137	125
MALUKU – PAPUA	1,378	105
Maluku	47	10
North Maluku	145	50
Papua	837	45
West Papua	349	-
Total for Indonesia	291,037	37,794

Source: Indonesian Ministry of Marine Affairs and Fisheries (2010)

Tilapia production in Indonesia is expected to continue to grow, as global demand increases. Demand for tilapia continues to grow particularly in the United States, where shrimp, with 1.86 kg annual per-capita consumption, was the most popular seafood in 2009 (Fitzsimmons et al., 2011). Per-capita consumption of tilapia was 0.54 kg, making tilapia the fifth most popular fish for Americans, just behind shrimp, tuna, salmon, and pollock. This consumption is the equivalent of 453,264 MT of live-weight fish. In U.S. retail stores, tilapia is the second best-selling fish behind salmon. Total import and farm gate sales for 2008 were $784.5 million (USD). Domestic growers received about $50 million of that total, while the balance went for tilapia grown outside the United States (Fitzsimmons et al., 2009).

6. Aquaculture Stewardship Council

In 2009, The Aquaculture Certification Council, the World Wildlife Fund, and Whole Foods unveiled plans for the next step in tilapia regulation. The creation of the Aquaculture Stewardship Council (ASC) which is a third-party group that audits and certifies fish farms that meet stringent requirements. These new standards grew out of open discussions between the stakeholders in the tilapia industry and their desire to see uniform standards applied to an industry that struggles with uneven product quality from its farmers across the globe. The decision depends on multi-stakeholders, and not merely buyer based as in the past. In fact, there are about 150 stakeholders, including a group of tilapia producers, seafood buyers and non-profit organizations (Fitzsimmons et al., 2009).

In August 2012, ASC announced that tilapia from Indonesia have become the first fish to meet its standards. This should allow the products to be sold at a higher price to environmentally conscious consumers (Cressey, 2012). The idea behind the establishment of the certification was, because aquaculture have been attacked by conservation groups for the pollution issues and the use of wild-caught fish as part of the feed ingredient. In fact, tilapia are significantly different from aquaculture species such as salmon and tuna. Tilapia are easily cultured in places where other species would not grow, and the feed is grain based. The ASC standards specify that tilapia carrying its brand can be fed 0.8 kilograms of wild fish for every kilogram of tilapia produced (Cressey, 2012).

7. Development of GESIT strain

Tilapia are omnivores in nature, and they can be maintained in an extensive cultivation system which depends on the natural productivity from the water or in an intensive cultivation system. which can be operated at a lower cost. In terms of reproduction, tilapia are paradox. The relative fecundity of the *Oreochromis* genus is low, at 6,000-13,000 eggs/kg/spawn. But this is compensated for by the high survival of fry due to their large size at hatching, their large yolk reserves, the mouth-brooding maternal care given until the fry are 10mm or larger and frequent spawning.

Tilapia present some challenges to fish culturists. Most *Oreochromis* species can reach sexual maturity within six to eight months of hatching at sizes often less than 100 g. Under some conditions, they mature in less than five months at 20 to 30 g. Unless controlled, the fish continue to reproduce, and off-spring compete with the initial stock for food, often resulting in stunted growth and unmarketable fish. Therefore, all-male monosex culture of tilapia is preferred because of males' fast growth and larger average size (Rothbard *et al*., 1987). Therefore, the culture of

monosex male tilapia is done frequently to overcome the problem of uncontrollable mating (Mair *et al*., 1997), although the supply of the male monosex tilapia is still very limited.

Several techniques have been adopted to produce all-male tilapia, including manual sexing, hybridization, genetic manipulation and sex reversal through sex hormone administration. Human error in manual sexing can be high, and the method also wastes the females. The problems associated with hybridization are the difficulties in maintaining the pure parental stocks that consistently produce a high percentage of male offspring, and reduction in egg fertilization. The use of hormones to produce monosex fish has been limited or prohibited in some countries because of market and/or environmental concerns. Therefore, the production of genetically "supermale" YY Tilapia has been suggested as the safest, most efficient and effective technology. When crossed with normal female (XX) fish, YY tilapia produce 98 to 100% male tilapia (XY) or genetically male tilapia (GMT). All-male tilapia result in more uniform culture populations and faster growth compared to mixed sex populations.

Considering the significance of tilapia, research on developing genetically male tilapia has been conducted on Nile tilapia in Indonesia since 2001. BPPT (Badan Pengkajian dan Penerapan Teknologi/ the Indonesian Agency for the Assessment and Application of Technology) and IPB (Institut Pertanian Bogor/ Bogor Agricultural Institute) initiated the YY male tilapia development program, production and began a cooperative effort with the "Research Centre for Freshwater Aquaculture" in Sukabumi, West Java, in 2002. The collaboration of researchers in three government institutions suggested that the YY male tilapia be named "Nila GESIT" (**Ge**netically **S**upermale **I**ndonesian **T**ilapia). The production of the super YY male tilapia and GESIT was

conducted at the Doc Experiment Pond – IPB, from 2001 to 2005, and the Research Centre for Freshwater Aquaculture, Sukabumi, from 2002 to 2006. Even though the research was done six years ago, the results have never been published for international readers. This paper is the first report of the development of the Super-YY Tilapia from Indonesia.

As outlined in Figure 2.6 and Table 2.3, hormonal treatment resulted in XY females, which were then crossed with XY males to produce YY males. Further crossing progeny testing, and hormone teatment generated YY females and mass production of all-male YY fish.

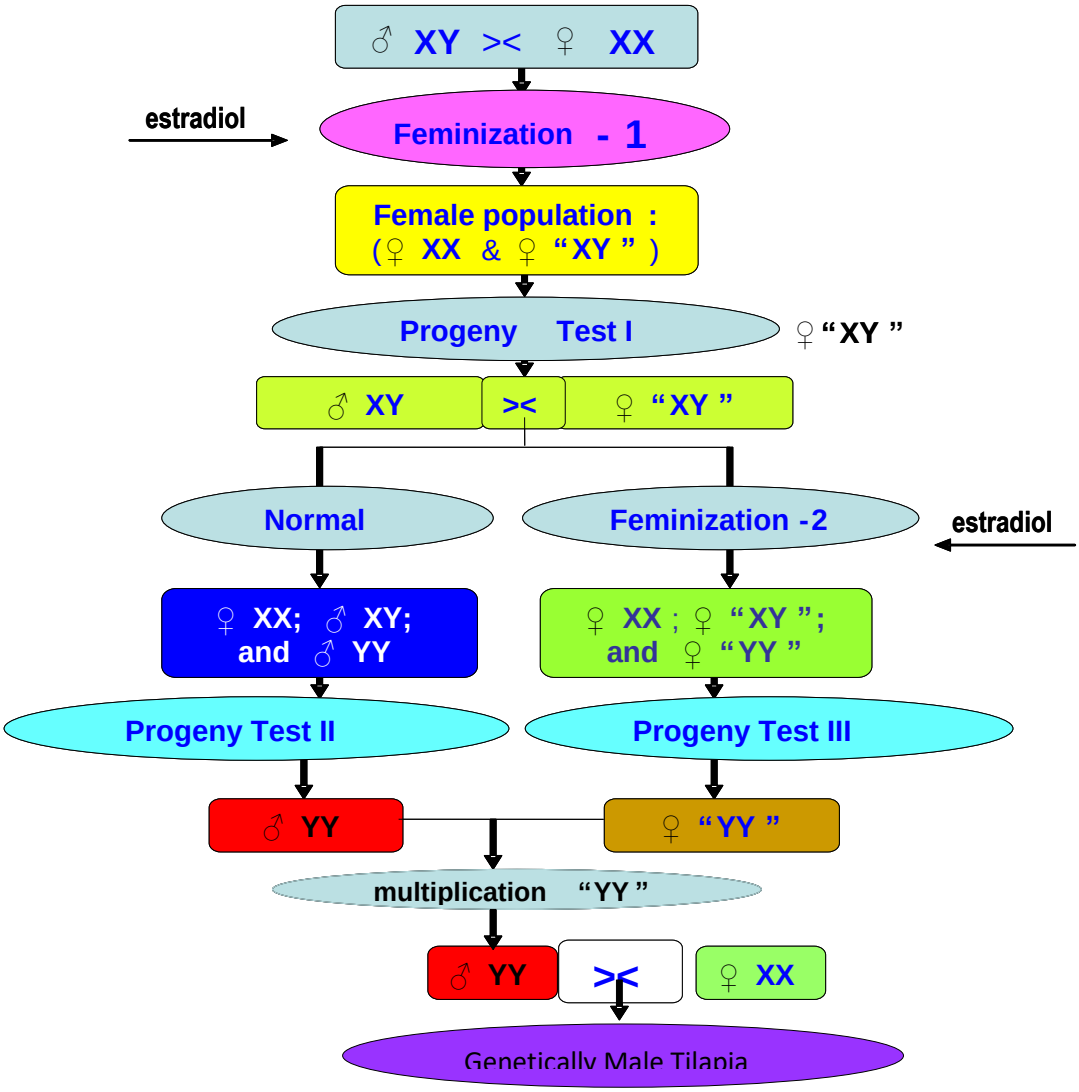


Figure 6. Steps in developing GESIT strain

Table 4. Development of YY male tilapia in Indonesia

Time	Activity	Result
July - Dec 2001	Feminisation through feeding which contains estradiol 17β 50 mg/kg for 10 day fries for 30 days.	120 female
Jan – Jun 2002	Feminisation	59 female
	Progeny test to produce ”XY” female	47 female
Jul - Nov 2002	Progeny test I, ”XY” female crossed with XY male.	3 ”XY” female
Dec 2002 – Jul 2003	”XY” female crossed with XY male to produce YY male. Only YY dan XY males were selected for furthe steps.	421 YY + 28 XY (all male)
Jun 2003 – Nov 2004	”XY” female crossed with XY male, the result then fed with feeding contains estradiol 17 β to produce ”YY” female.	129 XX, ”XY”, and ”YY” female
Dec 2003 - Jul 2005	Progeny test II, XY crossed with YY male from ”XY” to produce YY male.	19 YY male 9 → 100% ♂; 10 → ≥96% ♂
Aug 2004 – Oct 2005	Progeni test III, (”YY” , ”XY” dan XX) females crossed with XY (normal male) to produce ”YY” female.	2 fish, (♀: 98 – 100%)
Dec 2004 – Oct 2005	Progeny test III for female (”YY”, ”XY”, dan XX).	2 YY female
Jul 2005 - Oct 2006	Multiplication YY males through crossing YY male and ”YY” female from progeny test.	Parental = 663 fish > 8 cm = 797 fish

		5 – 8 cm = 454 fish 3 – 5 cm = 2401 fish 2-3 cm = 125 fish
Jul 2006 - Oct. 2006	Mass production of YY male, where YY male crossed with YY female	98-100% male tilapia

Genetically Supermale Indonesian Tilapia (GESIT) were officially released on December 15, 2006, by the Indonesian Ministry of Marine Affairs and Fisheries. Over 100,000 GESIT fish were distributed to 22 provinces by 2008. Based on reports from Cianjur, West Java, GESIT reach a size of 6 to 8 cm size 15 days, faster than previous tilapia strains. Other culturists reported that 100 kg of GESIT fingerlings resulted in 1,300 kg at harvest, double the weight when compared to the regular harvest. Table 2.4 describes the GESIT Tilapia parameter.

Table 5. Description of GESIT Tilapia

I	**Source**	
	GIFT Sukabumi	
II	**Morphology dan morphometrics**	
2.1	Age	10 month
2.2	Culture system	Hapa net in pond
2.3	Maximum Length	30 – 31.5 cm
2.4	Average Length	24 – 25 cm
2.5	Weight	500 – 680 g
2.6	Colour	Black
2.7	Ll	38
2.8	Vertebra	28

2.9	Dorsal Ventral Pectoral Anal Caudal	D. XVI – XVII. 12 – 13 V. I.5 P. 13 – 14 A. III. 9 – 10 C. 2.16
2.10	% fillet from	36,20 – 44 %
III	**Reproduction**	
3.1	Maturity	6 months
3.2	Weight at maturity	300 – 350 g
3.3	Fertility	Normal
IV	**Genetics**	
4.1.	Male progeny	**98 – 100%**

In Situbondo, East Java, the monosex fish have been cultured in abandoned shrimp ponds with 12 ppt salinity. At a density of 10 fish/m^2 starting with 1-2 cm fish, GESIT reach 300 g after 120 days with 60% survival and a feed-conversion ratio (FCR) of 0.8. In Subang, West Java, GESIT fry demand 30% higher prices than local fry. It takes 60 days for them to reach 10-g size with FCR of 1.1 to 1.2, compared to 75 days for local fry with 1.4 FCR.

Further experiment had been conducted to measure the survival and growth performance of fingerlings from GESIT crossed with normal female tilapia (JICA strain) in hapa nets in 300-m^2 concrete ponds with aeration. The densities were 250 fish/hapa net with three replicates.

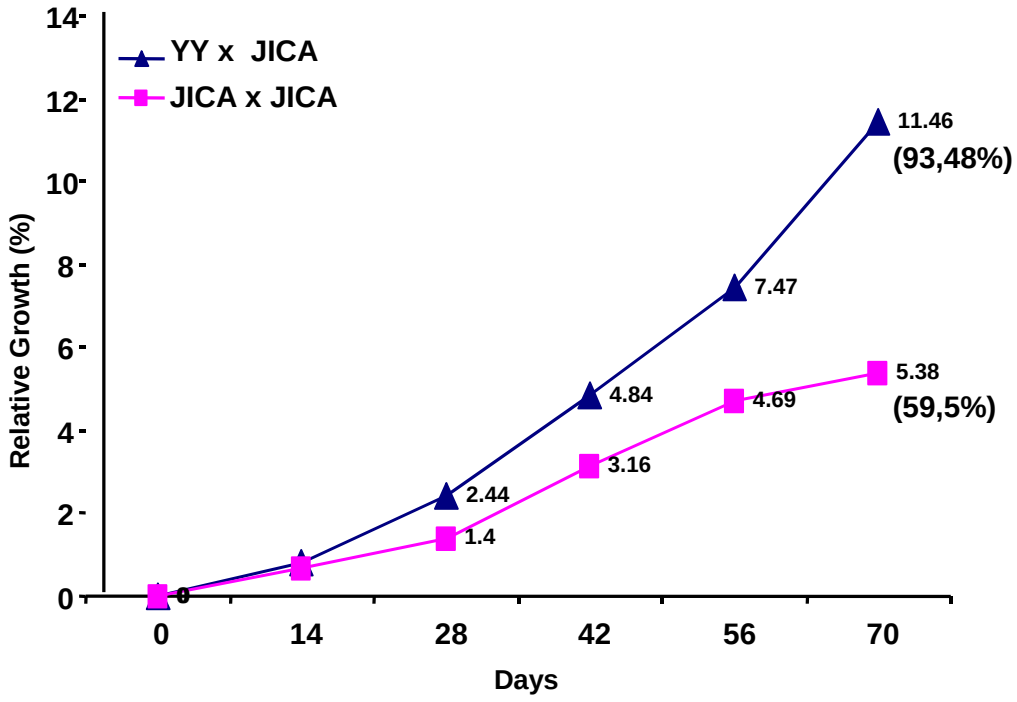


Figure 7. The growth of the YY ♂ x JICA ♀ and the JICA ♂ x JICA ♀

After 70 days, GESIT x JICA reached 11.46 g ± 1.20% compared to JICA x JICA at 5.38 g ± 1.51%. Figure 2.7 shows the growth curve. The FCR for GESIT x JICA was 2.11, lower than JICA x JICA's 3.04 after 70 days. Survival for GESIT x JICA was 82.8 ± 1.1%, compared to JICA x JICA at 89.1 ± 5.7%. The GESIT x JICA cross resulted in 93.8% males, compared to 59.5% males for JICA x JICA.

Tilapia Production, Market Report

Production, Consumption Increase Despite Economic Downturn

The increased adoption of tilapia by restaurants and fast food chains could lead to a doubling of global demand.

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Summary:
Global production and consumption of tilapia continues to rise. In 2008, China remained the major producer, with gains by its Asian neighbors and parts of Latin America. The global economic downturn and rising production costs hurt some smaller producers. China consumed half its huge production and showed a trend toward greater consumption of value-added tilapia. In U.S. retail stores, tilapia is now the second best-selling fish. The tilapia industry is working to bring "greener" tilapia products with improved quality control to market.

Worldwide tilapia production should reach 3 mmt in 2010, as demand for various tilapia products continues to grow. A strong rebound of production in China late in 2008, along with significant increases from the Philippines, Indonesia, Vietnam and parts of Latin America, more than equaled the huge losses that resulted from the winter storms in China in early 2008.

Despite problems with cold weather that hampered production at the start of the year, China remained the major producer of tilapia in 2008, accounting for almost half the year's production. However, that share of the market may have peaked, and the country may not be able to keep up with the rapid growth of its Asian neighbors.

China

China's tilapia exports increased about 4% from 215,400 mt in 2007 to 224,360 mt in 2008 (Table 1). While the United States and some European destinations were slightly down for the year, the increased sales to African markets were especially notable.

The value of exported tilapia products increased almost 50% from U.S. $491 million to $734 million for 2008. Some of this increase was from higher wholesale values, but a significant portion also came from value-added products. Prices for fresh and frozen fillets have dropped back from mid-2008 peaks as Chinese and global production increased in the later months of 2008, but value-added forms have retained higher values.

The China Aquatic Products Processing and Marketing Association reported that production costs were up 20% in 2008, and double-digit increases should be expected for the next few years. Also, in December 2008, China reported plans for a ban on carbon monoxide treatments for all fish and meat products, and a final decision is expected in late 2009. Carbon

Production costs were up 20% in 2008, and double-digit increases should be expected for the next few years.

Table 1. Tilapia exports from China, 2007 and 2008.

Importing Country	2008 Export Quantity (mt)	2007 Export Quantity (mt)
United States	118,559	122,073
Mexico	36,542	39,306
Russia	17,117	19,378
Nigeria	9,185	168
Ivory Coast (Cote d'Ivoire)	5,279	1,404
Israel	4,167	4,073
Poland	3,734	2,502
Netherlands	2,757	2,860
Equatorial Guinea	2,418	1,535
Belgium	2,282	1,753
Ukraine	1,752	1,091
Germany	1,708	1,996
Puerto Rico	1,698	1,270
France	1,623	1,838
Benin	1,603	338
Angola	1,589	979
United Arab Emirates	1,573	1,534
Ghana	1,327	815
Zambia	1,319	1,023
Namibia	994	70
Others	7,135	8,994
Total	224,360	215,000

monoxide was one of about 20 compounds banned from the food industry as the Chinese government responded to several food safety problems.

Other Asian Countries

Indonesia and Thailand both increased production and exports during 2008, taking advantage of tight markets and higher prices. The Philippines also increased production significantly, but virtually all of these sales were to domestic markets.

Bangladesh is another Asian country that rapidly increased production, reaching 67,000 mt in 2008. Most of this production was achieved in polyculture in existing carp and shrimp ponds. The vast majority of the fish produced in Bangladesh is sold in local markets.

Latin America, Caribbean

Production increased in most of the Latin American countries in 2008. Brazil and Mexico continue to be the largest producers with annual harvests approaching 100,000 mt. But in both cases, domestic demand is sufficient to absorb virtually all the fish.

Ecuador, Honduras and Costa Rica are the major exporters. Colombia and Cuba produce significant amounts, but export little. Jamaica, Panama, Nicaragua and Peru each have some export trade as well as significant domestic demand. Venezuela, Guyana and Guatemala each have small numbers of farms, but significant potential to become major producers if investments in production and infrastructure can be achieved.

During the financial crisis in late 2008, smaller producers and processors in Central and South America who didn't have long-term contracts with the larger institutional buyers of tilapia were especially hard hit. Bigger, more vertically integrated operations with long-term contracts to supply bigger grocery and restaurant chains did fine because their finances were set up for longer periods. For the most part, they were able to survive the financial situation.

The big farms in Nicaragua, Ecuador, Honduras and Costa Rica were doing well, while small operations in Ecuador and other locations were having problems with buyers unable to get the lines of credit they needed to make purchases.

Demand

China continued to be the world's biggest market for tilapia products. More than 50% of the 1.11 mmt it produced was consumed domestically. One interesting trend is the rapid increase in demand for value-added tilapia products in the Chinese domestic markets.

Increases in the number of both married and single women in the workplace have driven the demand for easy-to-prepare fish products with minimal waste and decreased the demand for live fish in grocery markets. Rapid urbanization, high-rise apartment living and Western-style grocery store purchases are certain to reinforce these changes in demand.

The restaurant tradition of holding live fish in tanks continues, however. Improvements in tank appearance with better construction and maintenance provide a synergy with tilapia and their hardiness in crowded conditions that can further improve the role of tilapia in Chinese cuisine.

Demand for tilapia continues to grow in the United States, where shrimp, with 1.86 kg annual per-capita consumption, was the most popular seafood in 2008. Per-capita consumption of tilapia was 0.54 kg, making tilapia the fifth most popular fish for Americans, just behind

Consumers' increasingly urbanized lifestyles are supporting rising sales of new value-added tilapia products.

pollock. This consumption is the equivalent of 453,264 mt of live-weight fish.

In U.S. retail stores, tilapia is now the second best-selling fish behind salmon. Total import and farm gate sales for 2008 were U.S. $784.5 million. Domestic growers received about $50 million of that total, while the balance went for tilapia grown outside the United States.

During the recession, experts expected to see a decrease in tilapia consumption. In 2008 and early 2009, a shift in consumption patterns with some decrease in fresh and frozen fillet sales to restaurants was noted, but at the same time, there was an increase in grocery store sales, especially frozen, value-added product forms. Some reports have noted similar situations in the European Union. Basically, consumers ate tilapia less in restaurants, but prepared more at home.

Basically, consumers ate tilapia less in restaurants, but prepared more at home.

Trends

Farmers and processors everywhere were hearing demands to make their products and operations more environmentally friendly, as the clamor for "green" products continues to grow. The Aquaculture Certification Council, World Wildlife Fund, Whole Foods and others have led the efforts to certify farms and processors and bring "greener" tilapia products to market. An associated effort is for improved quality control for products sold in major consuming regions such as the United States and European Union.

The adoption of tilapia by some of the fast food chains is a very positive step for the tilapia industry. Long John Silver's, part of Yum Brands, has used tilapia in chainwide promotional campaigns. This very positive development could lead to eventual distribution to other chains and a doubling of global demand.

Another major trend in the tilapia industry is that more value-added products are coming to market. More specialty-type products, such as center-cut loins, stuffed and crusted tilapia prepared meals or ready-to-cook meals, are processed and packaged in the producing countries. Others are prepared in the U.S. and Europe from imported product.

Innovative packaging such as resealable bags that contain 2 or 3 kg of frozen fillets that allow consumers to take what they need for each meal are popular in the U.S. and E.U. Multicolor, modified-atmosphere and other high-tech packages with recipes and nutritional information are quickly becoming the norm for retail packages in grocery stores, club stores and hypermarkets.

Perspectives

Tilapia farming, processing and consumption had to negotiate severe problems in 2008, with a global financial crisis and winter storms in the largest production region. But global production and consumption both increased, and prices improved for farmers and processors for at least part of the year.

These trends will likely continue through 2009 and into 2010. As economies come out of the recession, the tilapia industry appears poised to accelerate its growth.

The adoption of tilapia by some of the fast food chains is a very positive step for the tilapia industry.

ANIMAL HEALTH & WELFARE (/ADVOCATE/CATEGORY/ANIMAL-HEALTH-WELFARE)

GESIT tilapia: Indonesia's genetic supermales

Saturday, 1 May 2010

By Ratu Siti Aliah , Komar Sumantadinata , Maskur and Sidrotun Naim

All-male tilapia result in more uniform culture populations and faster growth

Tilapia are a paradox in terms of reproduction. The relative fecundity of the *Oreochromis* genus is low, at 6,000-13,000 eggs/kg/spawn. But this is compensated for by the high survival of fry due to their large size at hatching, their large yolk reserves, the mouth-brooding maternal care given until the fry are 10mm or larger and frequent spawning.

Tilapia present some challenges to fish culturists. Most *Oreochromis* species reach sexual maturity within six to eight months of hatching at sizes often less than 100 grams. Under some conditions, they mature in less than five months at 20 to 30 grams.

Unless controlled, the fish continue to reproduce, and offspring compete with the initial stock for food, often resulting in stunted growth and unmarketable fish. Therefore, all-male monosex culture of tilapia is preferred because of males' fast growth and larger average size.

Two-month-old all-male tilapia exhibit faster growth performance than that of mixed populations.

All-male methods

Several techniques have been adopted to produce all-male tilapia, including manual sexing, hybridization, genetic manipulation and sex reversal through sex hormone administration. Human error in manual sexing can be high, and the method also wastes the females. The problems with hybridization are the difficulties in maintaining the pure parental stocks that consistently produce 100 percent male offspring and reduction in egg fertilization. The use of hormones to produce monosex fish has been limited or prohibited in some countries over market and/or environmental concerns.

Therefore, the production of genetically “supermale” tilapia YY has been suggested as the safest, most efficient and effective technology. When crossed with normal female (XX) fish, YY tilapia produce 98 to 100 percent male tilapia (XY) or genetically male tilapia (GMT). All-male tilapia result in more uniform culture populations and faster growth compared to mixed sex populations.

Indonesian tilapia research

In Indonesia, Nile tilapia (*Oreochromis niloticus*) are considered an important culture species by the Indonesian Ministry of Marine Affairs and Fisheries. They have high economic value and are popular with local fish farmers, who find them easy to farm in well-established culture technology. There is high demand for tilapia, both for export and domestic markets. In addition, the species holds high potential for large-scale production.

Considering the significance of tilapia, research on developing genetically male tilapia has been conducted on Nile tilapia in Indonesia since 2001. As outlined in Table 1, treatment with hormone resulted in XY females, which were then crossed with XY males to produce YY males. Further crossing and hormone teatment generated YY females and mass production of all-male YY fish.

Aliah, Development of YY male tilapia, Table 1

Time	Activity	Result
July-December 2001	Feminization through feeding diet containing estradiol from 10 days post-hatch for 30 days	120 females
January-June 2002	Feminized fish grow out Progeny test preparation to produce XY female	59 females 47 females
July-November 2002	Progeny test I – XY female crossed with XY male	3 XY females
December 2002-June 2003	XY female crossed with XY male to produce YY male; only YY and XY males selected for further steps	421 YY males + 28 XY males
June 2003-November 2004	XY female crossed with XY male; resulting fish then given feed containing estradiol to produce YY female	129 XX, XY and YY females
December 2003-July 2005	Progeny test II – XY crossed with YY male from XY to produce YY male	19 YY males – 9, 100% male, 10, ≥ 96% male
August 2004-October 2005	Progeny test III – YY, XY and XX females crossed with XY (normal male) to produce YY female	2 females
December 2004-October 2005	Progeny test III for female – YY, XY and XX	2 YY females
July 2005-October 2006	Multiplication of YY males through crossing YY male and YY female from progeny test	663 fish
July 2006-October 2006	Mass production of YY male; YY male crossed with YY female	All-male tilapia

Table 1. Development of YY male tilapia in Indonesia.

GESIT tilapia

Genetically supermale Indonesian tilapia (GESIT) were officially released on December 15, 2006, through the Indonesian Ministry of Marine Affairs and Fisheries. Over 100,000 GESIT fish were distributed to 22 provinces by 2008.

Based on reports from Cianjur, West Java, GESIT reach a size of 6 to 8 cm size 15 days faster than earlier tilapia lines. Other culturists reported that 100 kg of GESIT fingerlings resulted in 1,300 kg at harvest – double the regular harvest.

In Situbondo, East Java, the monosex fish have been cultured in abandoned shrimp ponds with 12 ppt salinity. At a density of 10 fish per square meter with 1- to 2-cm fish, GESIT reach 300 grams after 120 days with 60 percent survival and a feed-conversion ratio (FCR) of 0.8. In Subang, West Java, GESIT fry demand 30 percent higher prices than local fry. It takes 60 days for them to reach 10-g size with FCR of 1.1 to 1.2, compared to 75 days for local fry with 1.4 FCR.

The adoption of GESIT tilapia has reportedly led to double-size harvests.

GESIT crosses

Further research has been conducted to measure the survival and growth performance of fry from GESIT crossed with normal female tilapia (JICA strain) in hapa nets in 300-square-meter concrete ponds with aeration. The densities were 250 fish/hapa net with three replicates. The temperature was maintained between 23.6 and 25.4 degrees-C, and dissolved-oxygen levels were 2.8 to 4.8 ppm. pH varied 6.5 to 8.3, and ammonia content ranged 0.04 to 0.24 ppm.

After 70 days, GESIT x JICA reached 11.46 grams ± 1.20 percent compared to JICA x JICA at 5.38 g ± 1.51 percent. Fig. 1 shows the growth curve. The FCR for GESIT x JICA was 2.11 – lower than JICA x JICA’s 3.04 after 70 days. Survival for GESIT x JICA was 82.8 ± 1.1 percent, compared to JICA x JICA at 89.1 ± 5.7 percent.

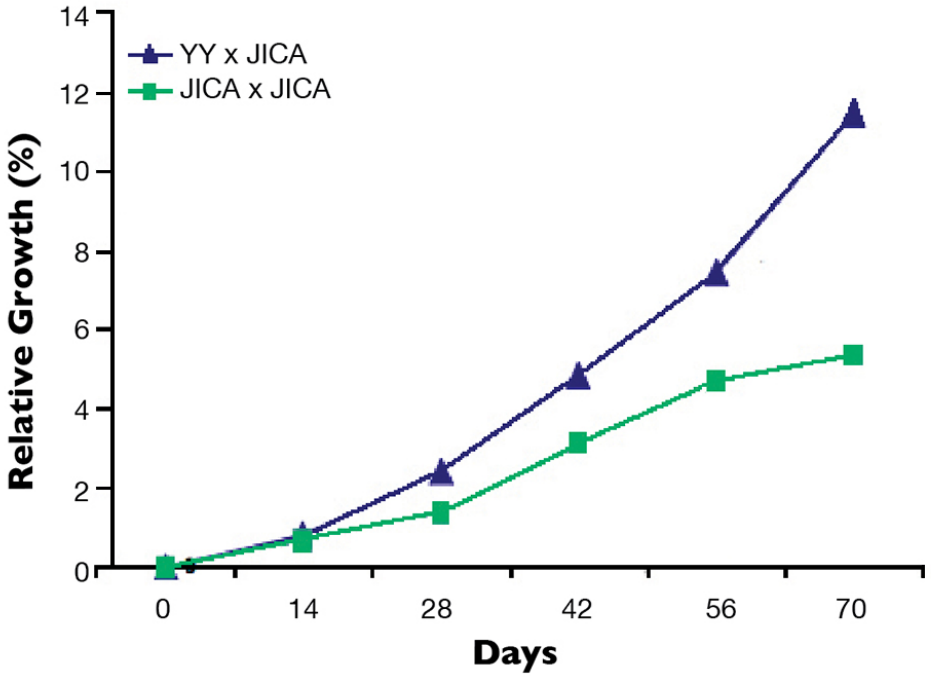

Fig. 1: Relative growth of YY male x JICA female and JICA male x JICA female crosses.

The GESIT x JICA cross resulted in 93.8 percent males, compared to 59.5 percent males for JICA x JICA.

(Editor’s Note: This article was originally published in the May/June 2010 print edition of the Global Aquaculture Advocate*.)*

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Tilapia Research and American Tilapia Association Update

Friday, March 5, 2010 12/30/1899 8:30:00 AM - 12/30/1899 5:30:00 PM California Room
Chair: Kevin Fitzsimmons

08:30	**Tekie Anday**	EFFICACY OF GROWSTONE AS A FILTER MEDIA FOR AQUACULTURE APPLICATIONS
08:45	**Cesar A. Hernandez**	Comparative analysis between polyculture and monoculture systems to measure the effect of tilapia fish (Oreochromis niloticus) on the production of shrimp (Litopenaeus vannamei) in a water recirculation system
09:00	**Rafael Martinez-Garcia**	EFFECTS OF SALINITY ON GROWTH AND SURVIVAL OF GIFT TILAPIA Oreochromis niloticus AND RED HYBRID TILAPIA Oreochromis niloticus x Orechromis mossambicus
09:15	**Sidrotun Naim**	THE POTENTIAL OF ANTIBACTERIAL ACTIVITY AND GREEN WATER PRODUCED BY GENETICALLY SUPERMALE INDONESIAN TILAPIA IN REDUCING VIBRIO ATTACK AND STIMULATING IMMUNE SYSTEM OF SHRIMP
09:30	**Mario Hernandez-Acosta**	POSITIVE EFFECTS OF DIETS SUPPLEMENTED WITH NUTRAFITO PLUS ON THE GROWTH OF PACIFIC WHITE SHRIMP Litopenaeus vannamei: A REVIEW
10:30	**Konrad Dabrowski**	THE EFFECTS OF DIETARY POLY-ß-HYDROXYBUTYRATE AND ASCORBIC ACID ON GROWTH, FEED UTILIZATION AND SURVIVAL RATE OF TILAPIA (Oreochromis niloticus) JUVENILS
10:45	**Emily Stutzman**	WHAT FACTORS CONTRIBUTE TO PRODUCTIVE GROUP-BASED TILAPIA AQUACULTURE IN RURAL UGANDA?
11:00	**Luisa Villamil**	EVALUATION OF SYNERGISM AMONG BATERIAL MIXTURE AS FOOD SUPPLEMENTATION ON NILE TILAPIA Oreochromis niloticus GROWTH AND SURIVAL RATE.
11:15	**Luisa Villamil**	NATIVE BACTERIA ISOLATION FROM NILE TILAPIA Oreochromis niloticus AND THEIR USE AS A POSSIBLE PROBIOTIC.
11:30	**Maria Lourdes Cuvin-Aralar**	Effect of different feeding management schemes on the aquaculture production of Nile tilapia Oreochromis niloticus in Lake Bato, Camarines Sur, Philippines
11:45	**Tri Nguyen**	DETERMINATION OF SUITABLE FEEDING FREQUENCY AND RATIO FOR NILE TILAPIA Oreochromis niloticus JUVENILE
01:30	**Kevin Fitzsimmons**	TILAPIA: 2009 STATE OF THE INDUSTRY REPORT

THE POTENTIAL OF ANTIBACTERIAL ACTIVITY AND GREEN WATER PRODUCED BY GENETICALLY SUPERMALE INDONESIAN TILAPIA IN REDUCING VIBRIO ATTACK AND STIMULATING IMMUNE SYSTEM OF SHRIMP

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Vibriosis caused by *Vibrio harveyi* is considered a serious disease in shrimp culture. Recent studies by Huervana *et al.* (2006), Muangkeow *et al.(*2007), and Cruz *et al.* (2008) suggest that green water has potential to reduce the risk of *Vibrio* infections in shrimp. Tendencia *et al.* (2004) observed that Tilapia can produce green water in shrimp-tilapia polyculture, which has antibacterial activity for *Vibrio.* Green-water technology has been effective and functional, as it inhibits pathogen growth, improves water quality, and stimulates the immune system of shrimp. In many Asian countries, shrimp ponds have been abandoned due to diseases, poor management, and environmental degradation. While many studies on shrimp-tilapia polyculture have been conducted in Thailand and the Philippines, similar research in Indonesia remains unknown or undocumented. In fact, Badan Pengkajian dan Penerapan Teknologi (Agency for the Assessment & Application of Technology), an Indonesian government research body introduced a new strain of *Oreochromis niloticus* named Genetically Supermale Indonesian Tilapia (GESIT) in 2006. GESIT will produce 98% - 100% male tilapia that is more productive and will give benefits to farmer.

Preliminary research on the effectiveness of tilapia-shrimp polyculture in reducing *Vibrio* attack has been conducted at Environmental Research Laboratory, the University of Arizona, USA. The implementation and field sampling would be delivered in two different provinces in Indonesia, which are Aceh and Tarakan, East Kalimantan. Both sites have been World Wildlife Fund for Nature (WWF-Indonesia)s BMP implementation projects since 2006/2007. Recent reports show that shrimp culture in Aceh faces big problems caused by the fact that pond preparation with pesticides is expensive for traditional plus farming (traditional system with feed input). Farmers are still using pesticides and not following BMPs. In Tarakan, the production becomes lower and lower over time in traditional farming system (no feed input, depends on natural feed).