

**Church Planting**

**Thai music ministries**



**มูลนิธิส่งเสริมชีวิตชาวเหนือ**  
**Northern Thai Foundation for Enablement**

**Development Projects**

**Community Outreach**

**Fish Hatchery**



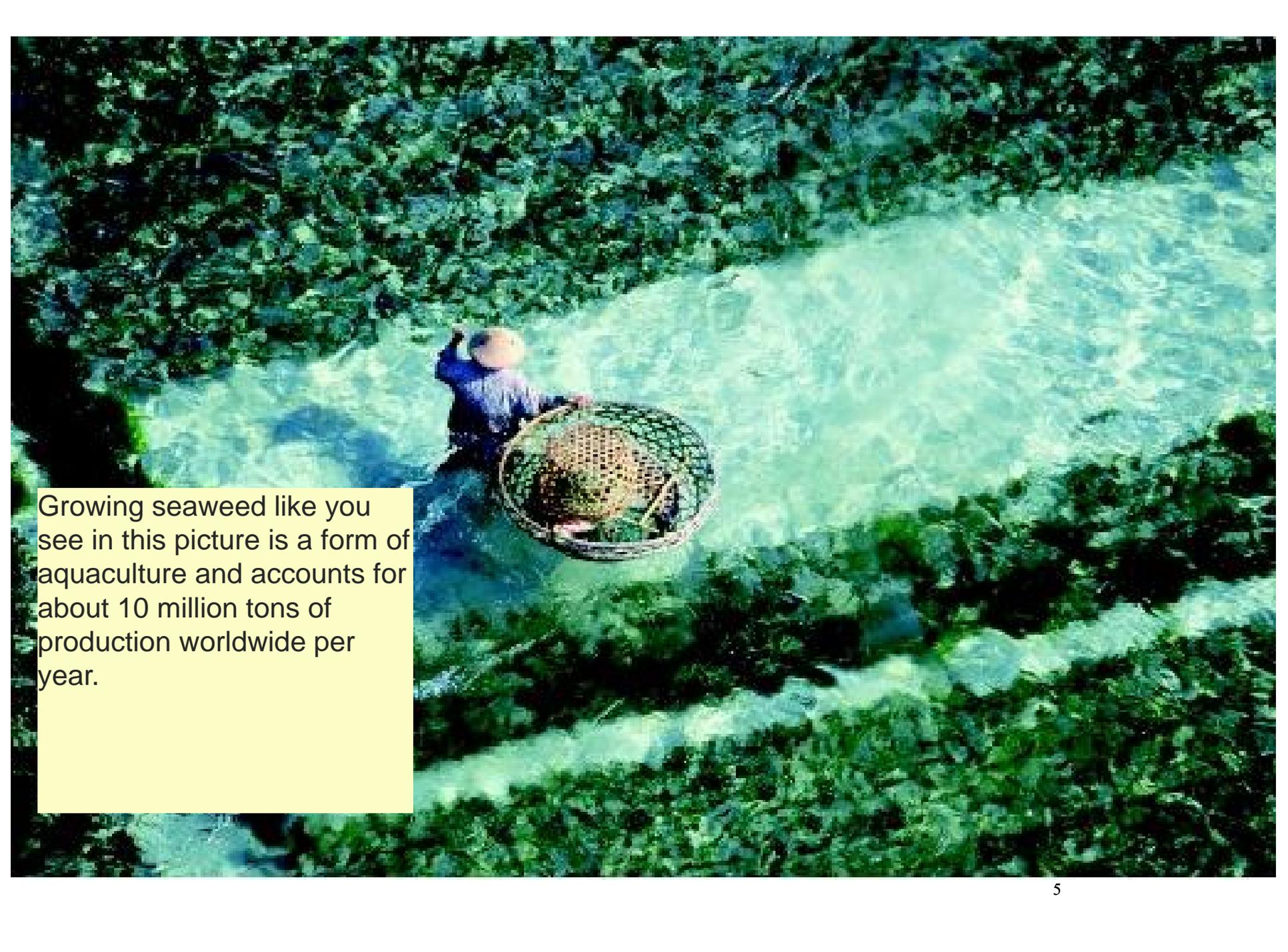
**ฟาร์มเชียงใหม่พัฒนาสัตว์น้ำ**

**Chiang Mai Aquatic Development Farm**

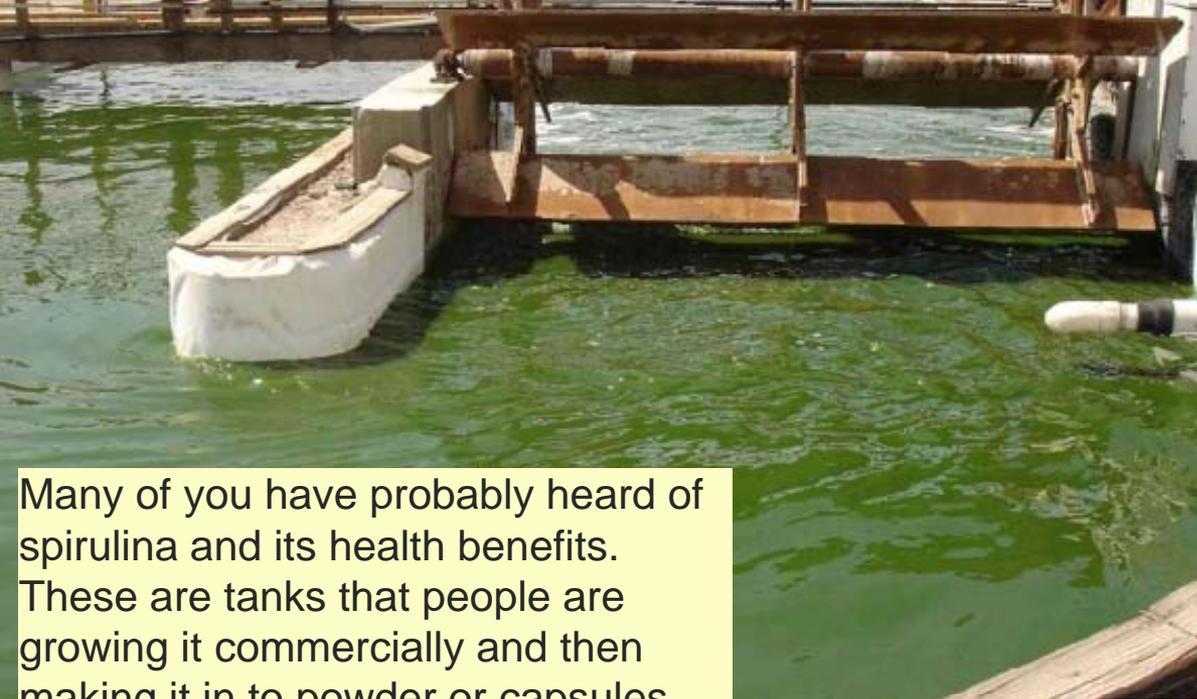
Mr. Randy Bevis, M.Sc, Asian Institute of Technology, Bangkok.  
Email: [Randy.Bevis@gmail.com](mailto:Randy.Bevis@gmail.com)

# What is Aquaculture?



An aerial photograph showing a person wearing a traditional conical hat and a blue shirt, standing in a shallow, rocky stream. The person is holding a large, round, woven basket filled with harvested seaweed. The water is clear and shallow, revealing the rocky bottom. The surrounding area is lush with green vegetation, including trees and bushes. The overall scene depicts a traditional method of seaweed harvesting in a natural, outdoor setting.

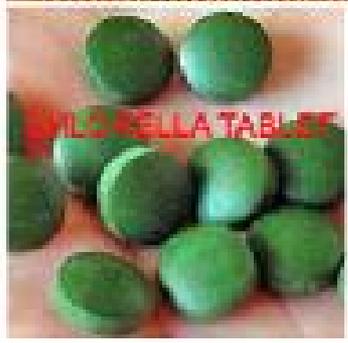
Growing seaweed like you see in this picture is a form of aquaculture and accounts for about 10 million tons of production worldwide per year.



Many of you have probably heard of spirulina and its health benefits. These are tanks that people are growing it commercially and then making it in to powder or capsules.

high in protein (but costs a lot more if you are just taking it for protien, high in balanced amino acids, many vitamins, lipids

Been shown to limit HIV replication in T cells, help people add weight, reduce cancer, toxic iron in the blood...



CHLORELLA TABLETS

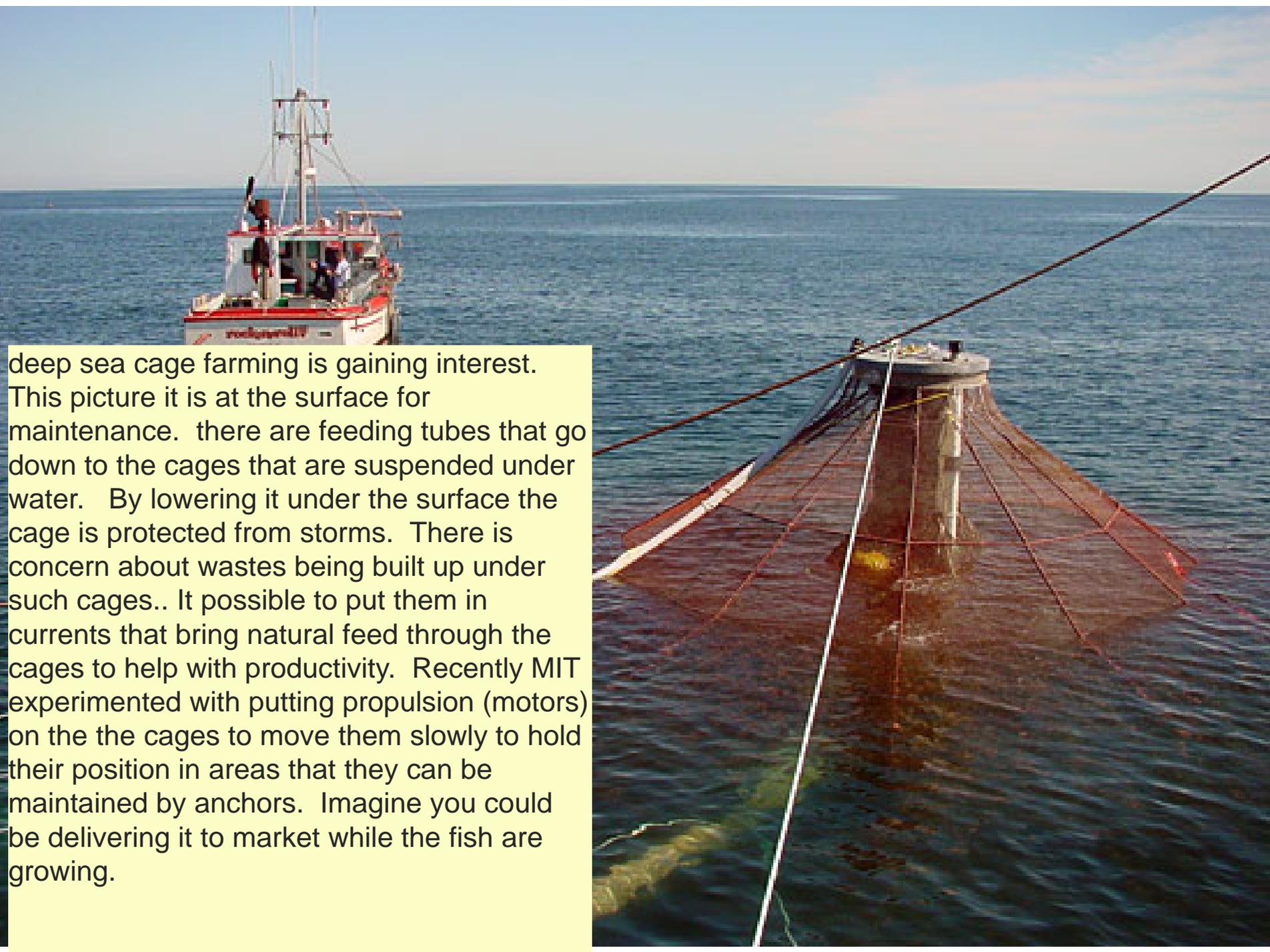
SPIRULINA TABLET





Culture in concrete tank

culture of spirulina can be done on a small scale like in these tanks. chemicals are put in the tanks and a small amount of sea salt and then stocked with a small amount of spirulina, it needs to be stirred 4 times a day and it can be harvested after about 4 days.



deep sea cage farming is gaining interest. This picture it is at the surface for maintenance. there are feeding tubes that go down to the cages that are suspended under water. By lowering it under the surface the cage is protected from storms. There is concern about wastes being built up under such cages.. It possible to put them in currents that bring natural feed through the cages to help with productivity. Recently MIT experimented with putting propulsion (motors) on the the cages to move them slowly to hold their position in areas that they can be maintained by anchors. Imagine you could be delivering it to market while the fish are growing.



Why is Aquaculture needed?

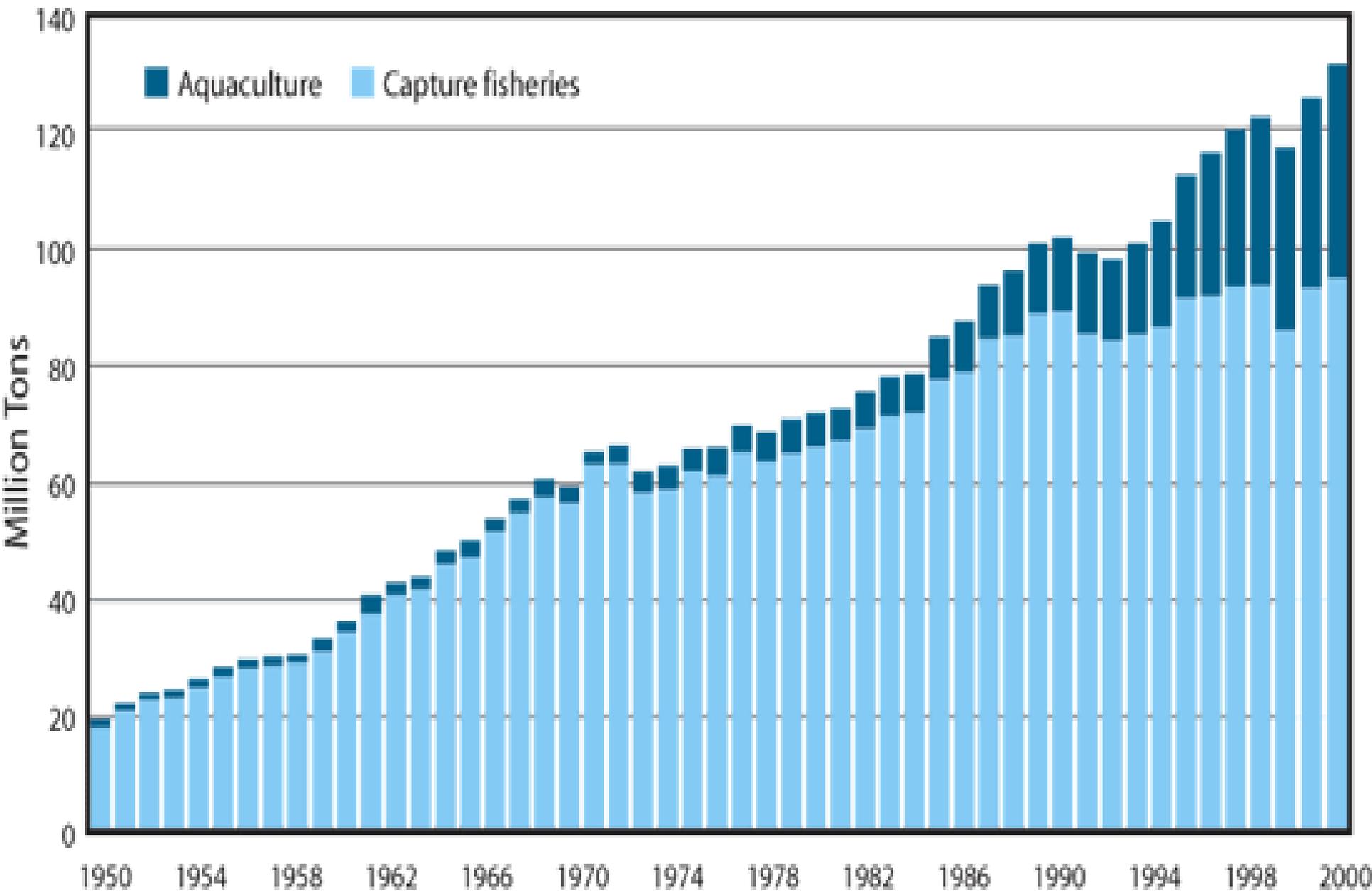
Where there is still good capture fisheries people won't likely want to risk raising fish when they can catch wild ones.







# World capture fisheries and aquaculture production





# Fish Facts

- Fish evolved in a very diverse environment, and 20,000 species exploit every possible niche
- Currently, there are ~140 species fish being farmed
- First publication on fish farming was 2500 BC
- In 2005, 43% of all fish consumed globally was produced by farming
- Aquaculture production growing at 9-10% annually, fastest sector of animal production

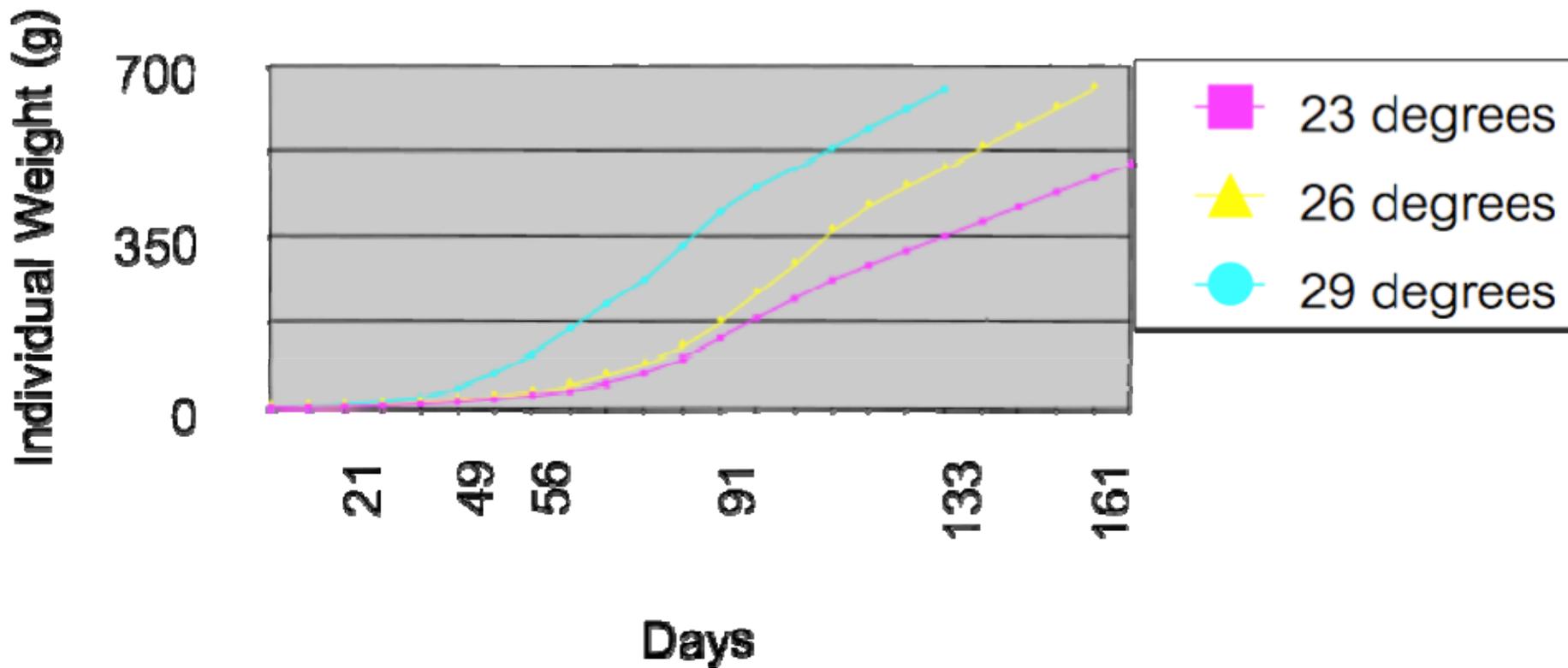
# Fish vs. livestock and poultry

- Major differences associated with aquatic existence
  - Fish maintain neutral buoyancy and do not need skeletal and muscular systems to oppose gravity
  - Fish excrete ammonia
  - Fish are cold-blooded
- Other differences
  - Fish exhibit indeterminate growth
  - Huge differences in digestive system among farmed fish
    - Fish are monogastric, but...
      - Gastric stomached fish (carnivores like salmon/trout)
      - Agastric (carp)

# Fish vs. livestock and poultry: differences associated with aquatic existence

- Fish exist in neutral gravity, no need for heavy skeleton
  - Dietary calcium and phosphorus needs are lower
  - Energy expenditures for locomotion are lower
- Fish excrete ammonia via the gills
  - Lower metabolic cost than excreting urea or uric acid
  - Higher caloric energy yield from metabolism of amino acids
- Fish are cold-blooded
  - Upside: no need to stay warm
  - Downside: rates of metabolism, digestion, etc. decrease in cooler water, plus membrane fluidity must change

Growth Rates for Tilapia at Three Different Temperatures in Brazil





# Efficiency of fish compared to livestock

- FCR values less than 1.0 for fish
- FCR values 1.6-1.8 for chickens
- FCR values 8-10 for cattle
- Yield of high-quality protein from salmonids is 55%
- Total yield from poultry or cattle is lower and quality varies with cut

# Important things to consider in making fish farming sustainable

- What species do we choose to raise?
  - Carnivores, omnivores or herbivores

# Important things to consider in making fish farming sustainable

- What species do we choose to raise?
  - Carnivores, omnivores or herbivores
  - Examples: Salmon, seabass, snakehead fish are carnivores, tilapia an omnivore and grass carp are herbivores

Shrimp have gotten a pretty bad rating in the past for environmental destruction and being wasteful since they need lots of fish meal in their diet.

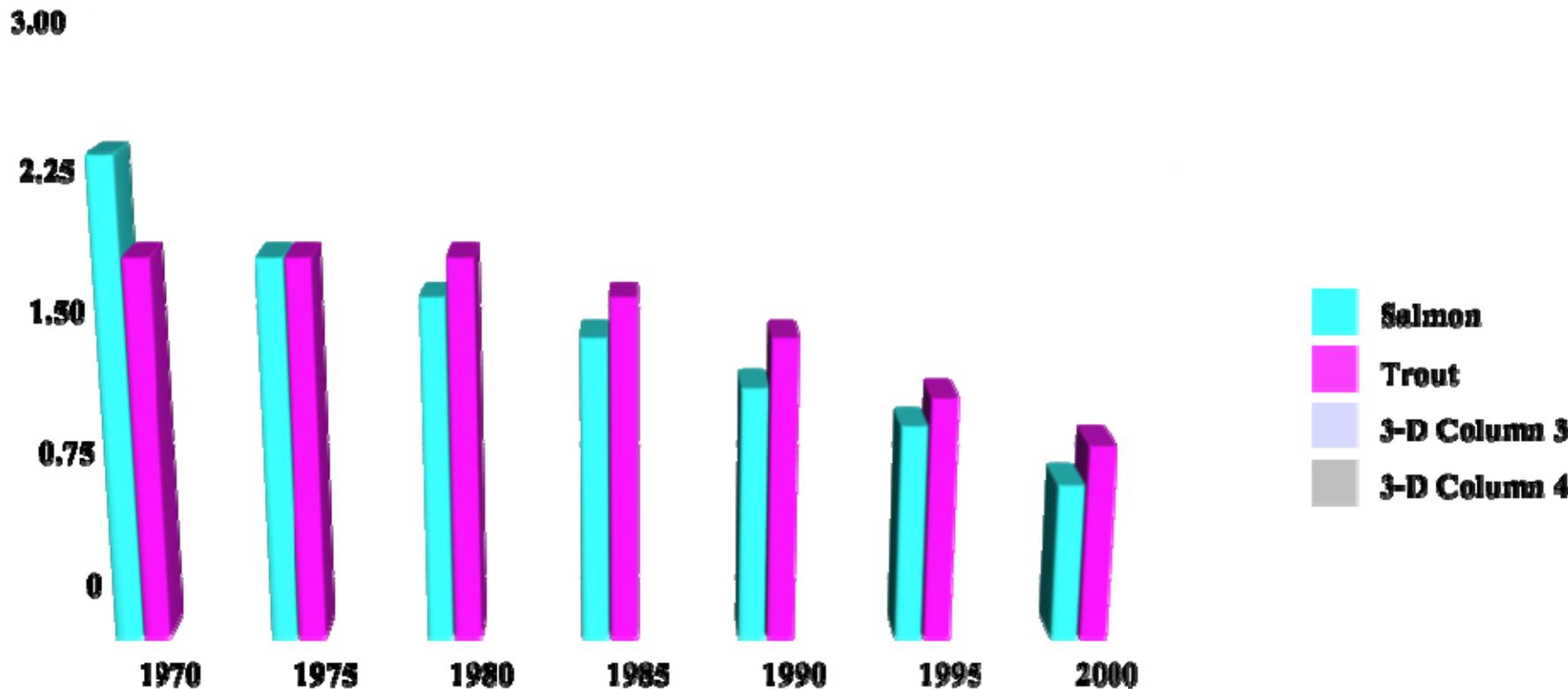
85% of the worlds shrimp production comes from Asia with Thailand being the biggest producer in the world

There have been many improvements the last few years and it is possible to grow shrimp sustainably and even in closed systems that don't put water out into the environment.

There are both carnivorous and omnivorous species of shrimp so if people would focus on the omnivorous species of shrimp it would reduce the amount of fish meal needed in their diet. FCR rates have been able to reduce down to about 1.2 now when before it was well over 2. The white shrimp has replace the tiger shrimp for the most part in production



# Changes in feed conversion ratios for salmon and trout



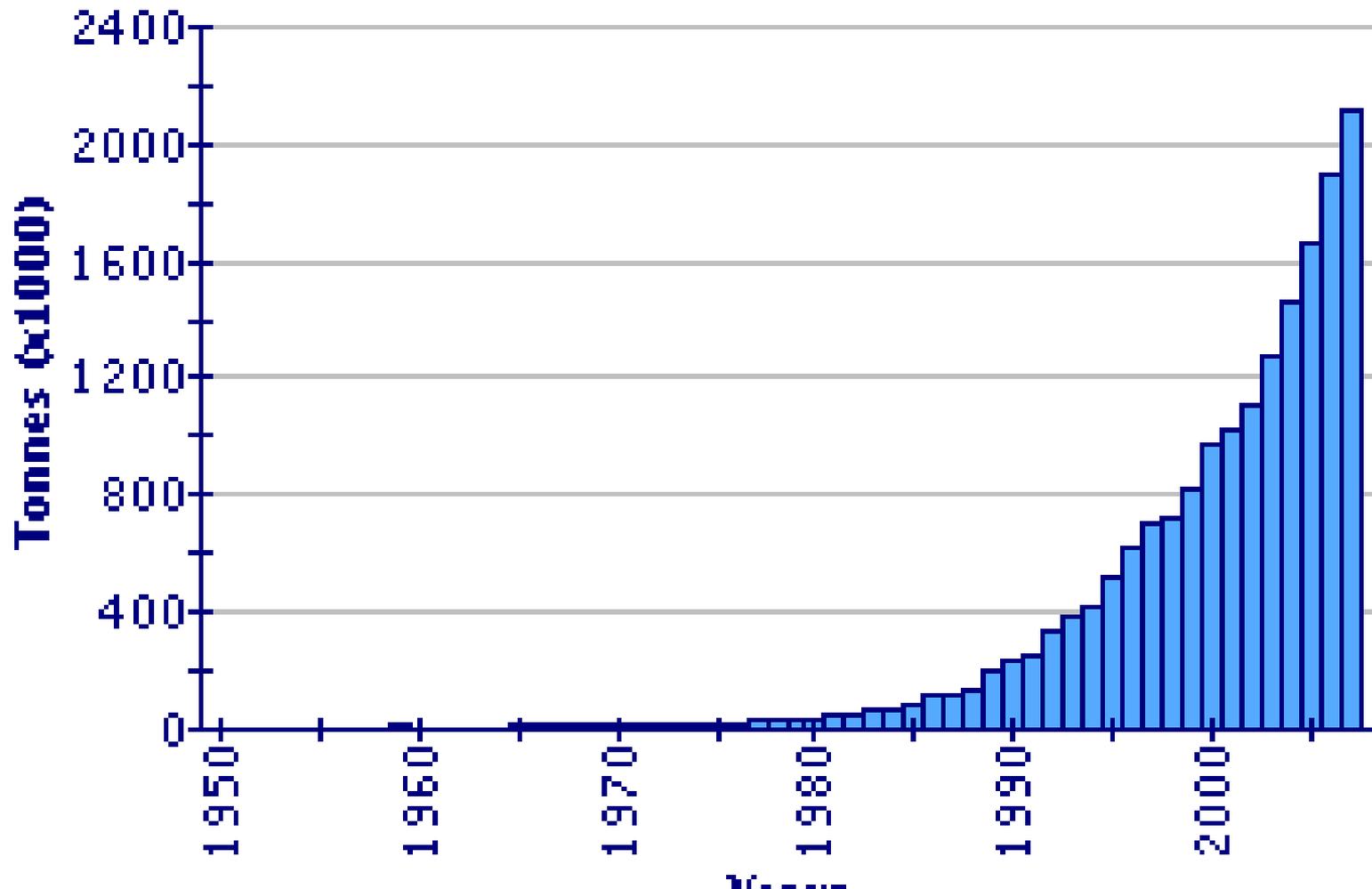
# Important things to consider in making fish farming sustainable

- What species do we choose to raise?
  - efficient converters of feed and preferably fish that feed low on the food chain that don't depend on fish meal in their diet.

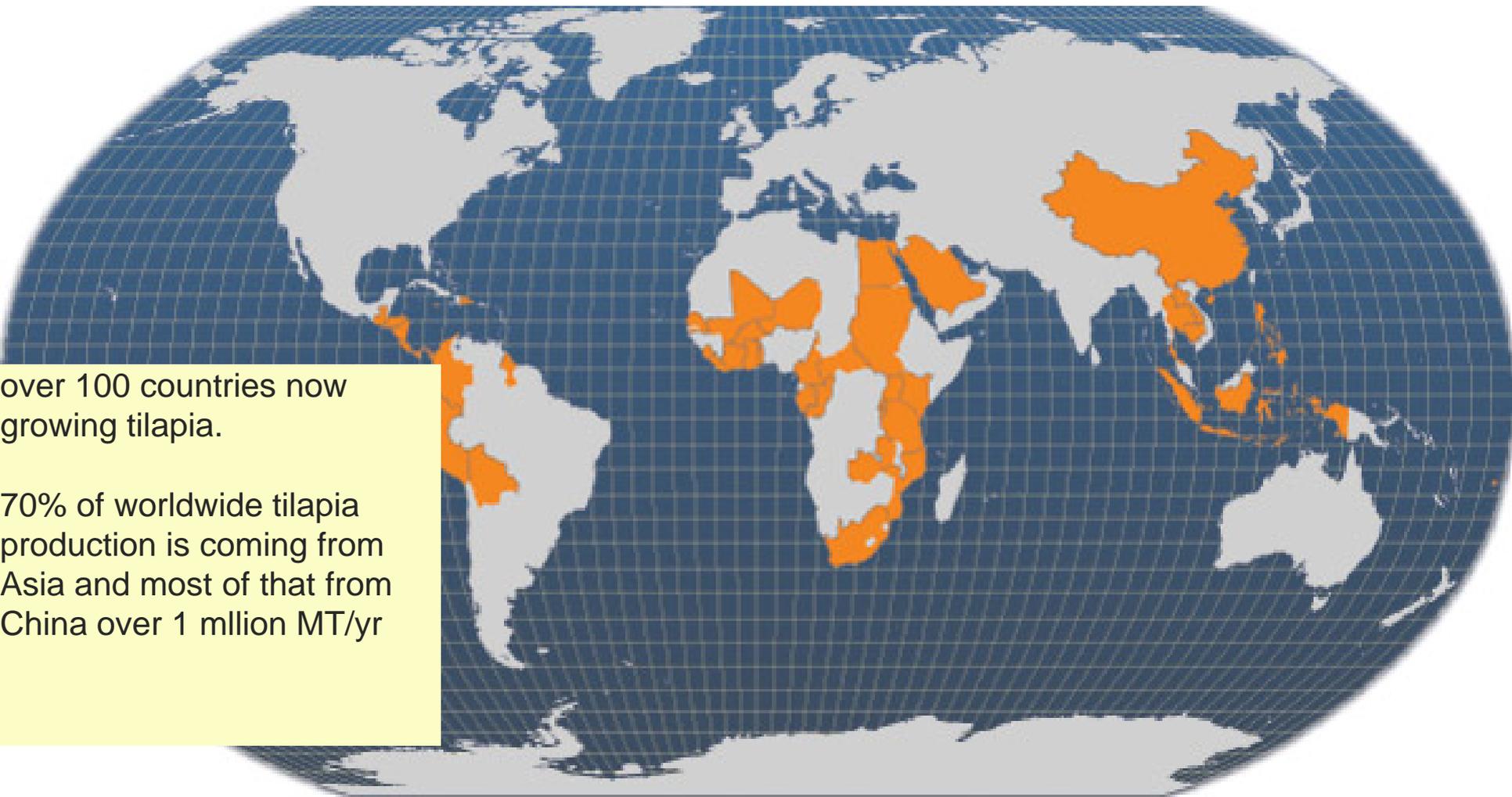


**Tilapia: The fish of the 21st Century?**

# Global Production of Tilapia



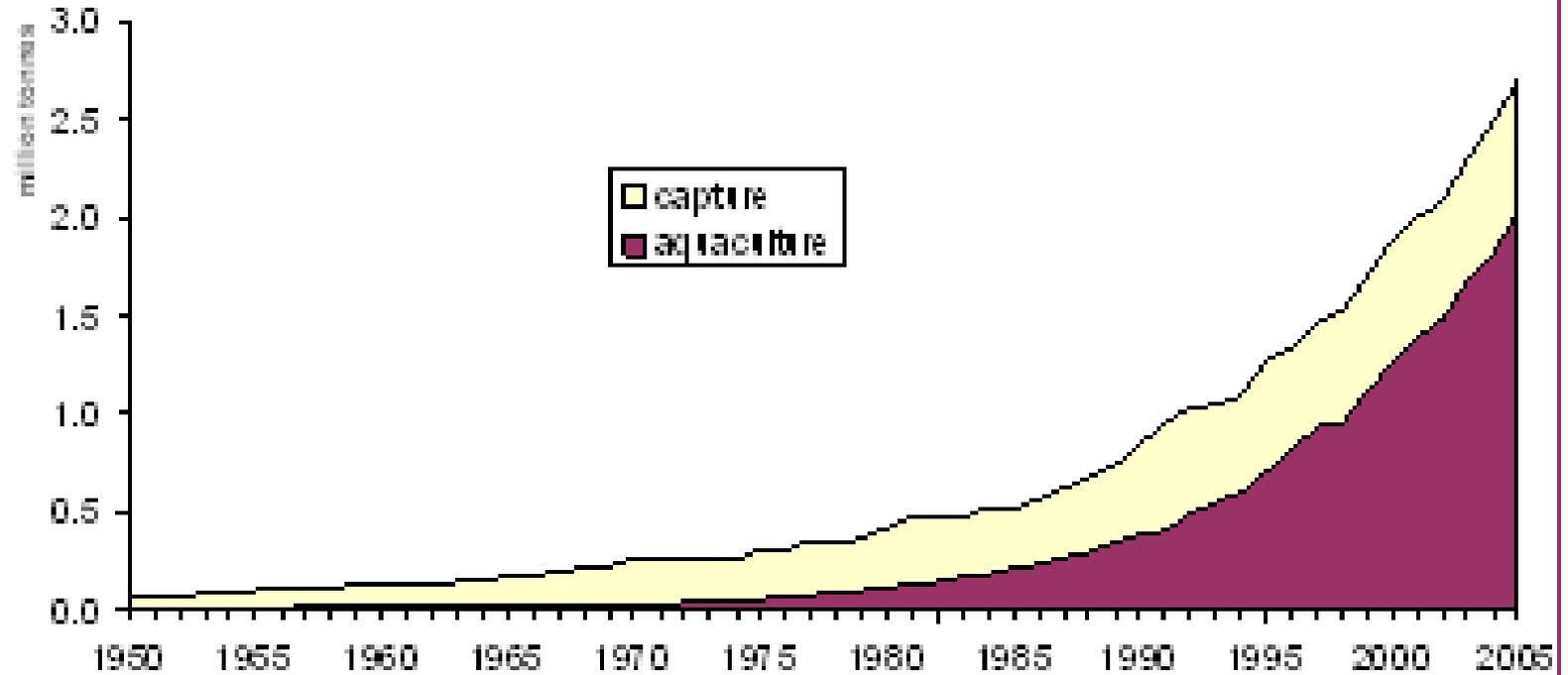
# Main tilapia producing countries



over 100 countries now growing tilapia.

70% of worldwide tilapia production is coming from Asia and most of that from China over 1 million MT/yr

# World tilapia production



# Why is Tilapia considered the most important Aquaculture species for the 21<sup>st</sup> Century?

- Now grown in over 100 countries, estimated production for 2010 at over 3 million metric tons. (659,000 t in 1995)
- Low FCR, omnivorous, phytoplankton filter feeder

**Deloitte™ and a  
company  
are excited to see this picture.**



Farm Budget Analysis for CRSP data (1996) recalculated for Chiang Mai Market Prices in April for Tills

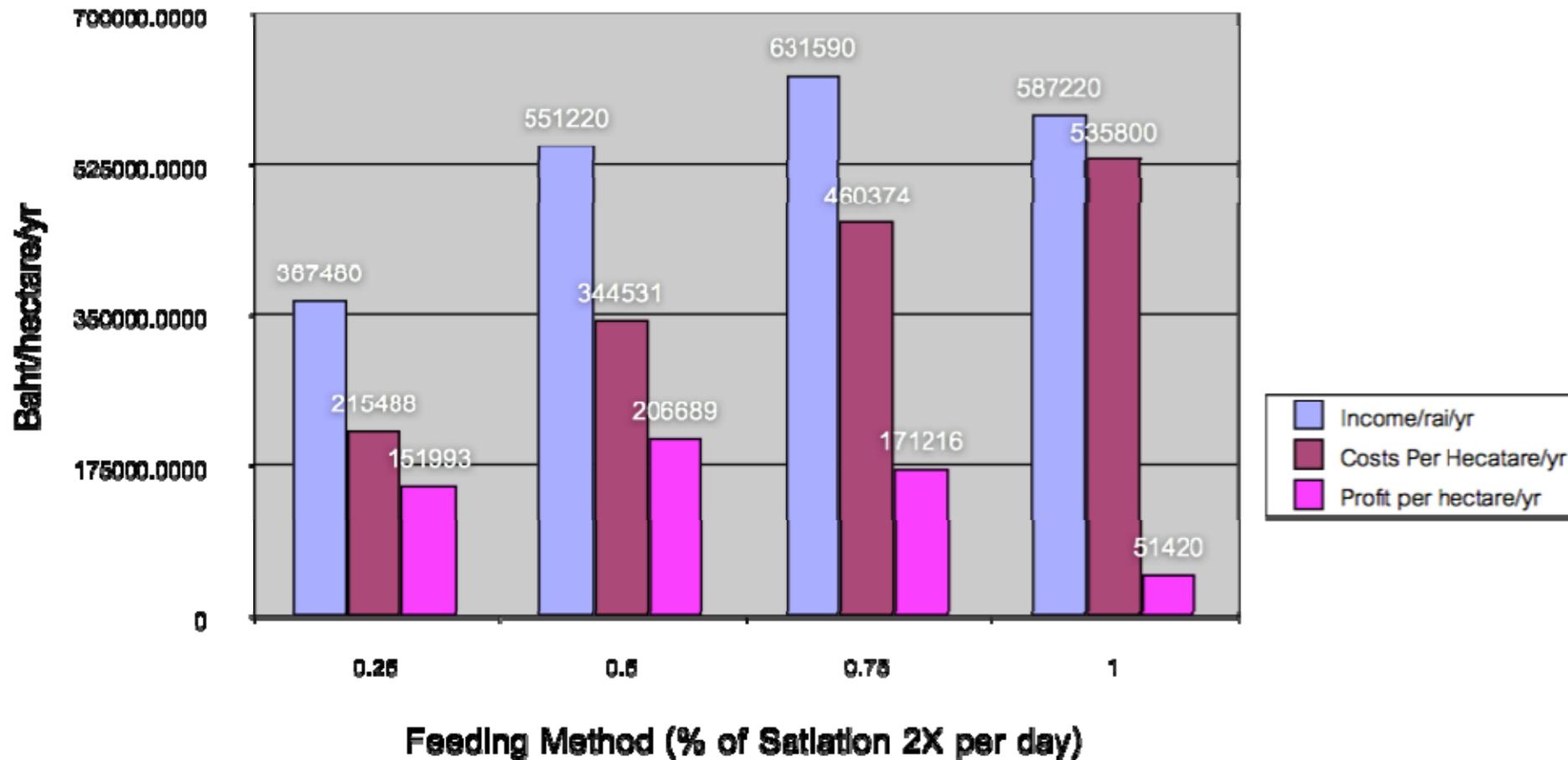
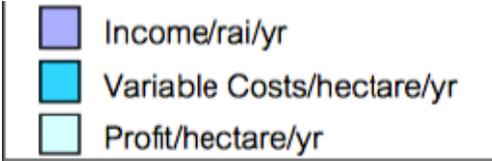


Table of values for CRSP experiment in which tilapia were grown in fertilized ponds (28N/ha/day, 7P/ha/day) and fed varying rations of 30 % protein feed twice daily. Fish were stocked at 2.7/m<sup>2</sup>. Chiang Mai costs and market values for 2003 were used.

Feeding ratio (%)	25%	50%	75%	100%
Final Size (g)	250	388	403	416
Farm Gate Price (BT) per kg	25	30	30	30
Gross fish yield (kg/ha/yr)	12106	18374	21053	19574
Net fish yield (kg/ha/yr)	11425	17714	20366	18901
FCR	0.70	0.88	1.10	1.42
Income/hectare/yr	367480	551220	631590	587220
Food cost (17 baht/kg)	135058	265001	380844	456270



**Farm Cost Benefit Analysis per hectare pond (2 crops/yr) with Varying Stocking Density with Fert. (2)**

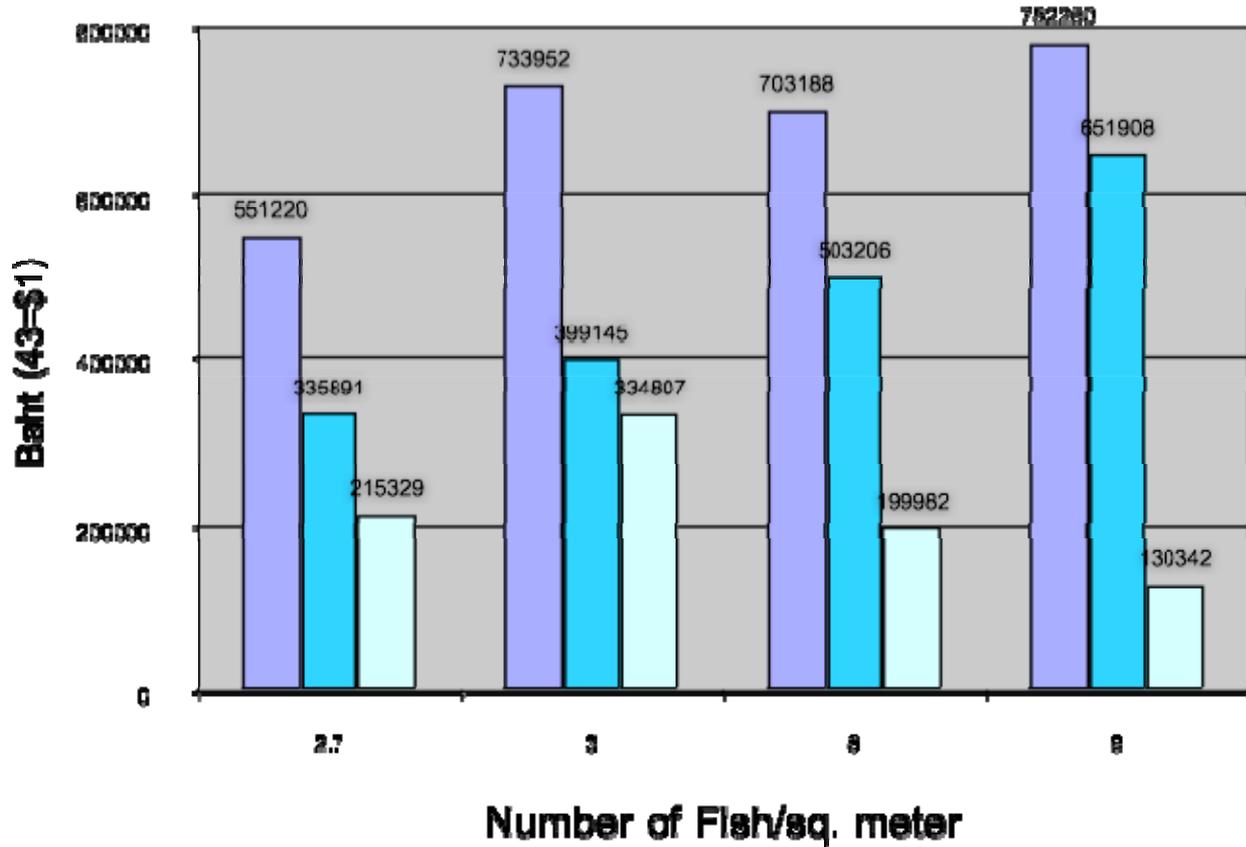


Table of values for CRSP experiment in which tilapia were grown in fertilized ponds (28N/ha/day, 7P/ha/day) at varying stocking densities. Fish were feed twice daily 30 % protein at 50 % ration.

### Chiang Mai costs and market values.

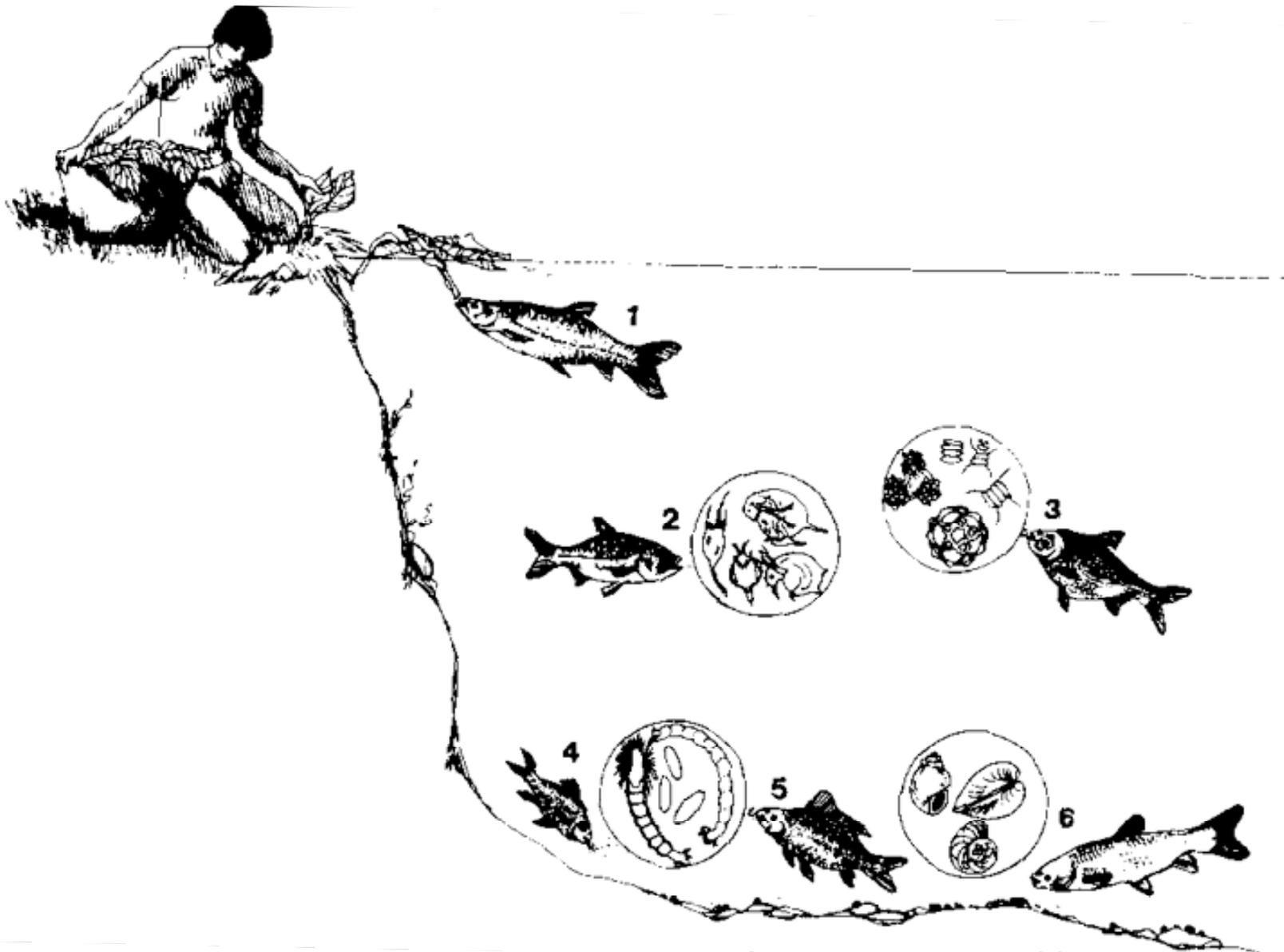
Stocking Density per sq. meter	2.7	3	6	9
fish per hectare pond(50 % feed + fertilizer)	2700	3000	6000	90000
Individual fish size (g)	388	447	304	272
Farm gate price (Bt) per kg	30	32	27	25
total biomass/hectare pond	1837	2293	2604	31290
FCR	0.88	0.88	1.04	1.18
Income/hectare/yr	5512	7339	7031	78225
food cost (17 Bt/kg for 30	2650	3272	4217	56085

Grass carp are actually still the most grown fish in the world ahead of tilapia because it is a fish that the Chinese have grown the most historically. Some call it the aquatic cow as it eats grass and aquatic weeds. We have a few of them in our ponds and you never have to worry about grass growing in your ponds with them present. I have watched them put their heads out of the water and pull grass off the sides of the fish pond. They are a great fish for development projects where there are no resources for feeding fish. This is an issue in many poor areas. You can do what is called green manuring in the pond. Planting grasses that are high in nutrients around the pond and then cutting the grass and throwing it in the pond. The grass carp eat it and break down the nutrients from the grass and make it available for phytoplankton to use thus "greening" the pond.



# Chinese Carps





Habitat and feeding niches of the principal species in classical Chinese carp culture. (1) Grass carp feeding on vegetable tops. (2) Big head feeding on zooplankton in midwater. (3) Silver carp feeding on phytoplankton in midwater. (4) Mud carp feeding on benthic animals and detritus, including grass carp feces. (5) Common carp feeding on benthic animals and detritus, including grass carp feces. (6) Black carp feeding on mollusks.

# Polyculture

- Raising several species at once
- Plant eaters: silver barb, grass carp
- Plankton feeders: tilapia, Silver carp
- Zooplankton feeders: big head carp
- Bottom feeders: common carp,
- Predators: catfish, snakehead fish, sea bass



•Rohu Carp

•Common Carp

# Indian Major Carps: Rohu, Mrigal and Catla





climbing perch



Featherback fish



Silver Barb fish



Giant Gourami

# walking catfish



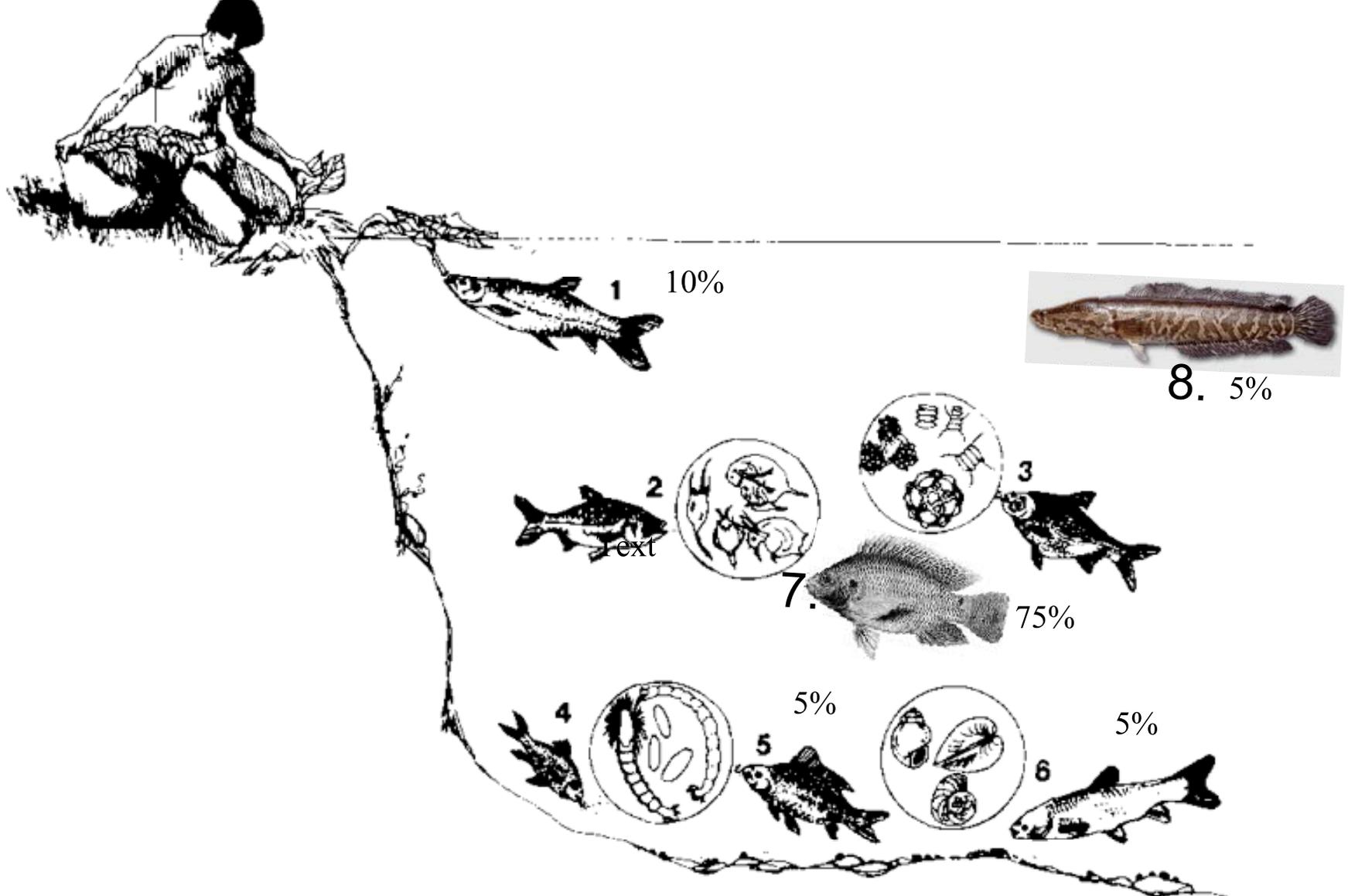


กรมประมง  
ศูนย์วิจัยและพัฒนาการเพาะเลี้ยงสัตว์น้ำจืด  
เชียงใหม่  
โทร. 0-2252-1191

## •Walking catfish

You would call this intensive aquaculture since the stocking density is high but since it is just in a guys backyard and a small tank its impact isn't so great and it is a good use of space and water

**QuickTime™ and a decompressor are needed to see this picture.**



Habitat and feeding niches of the principal species in classical Chinese carp culture. (1) Grass carp feeding on vegetable tops. (2) Big head feeding on zooplankton in midwater. (3) Silver carp feeding on phytoplankton in midwater. (4) Mud carp feeding on benthic animals and detritus, including grass carp feces. (5) Common carp feeding on benthic animals and detritus, including grass carp feces. (6) Black carp feeding on mollusks. 7. Tilapia omnivore that feeds mostly on phytoplankton 8. snakehead fish carnivore that feeds on fish, frogs other fish that could be added: Silver barb feeds on plants, gourami, catfish, climbing perch other predators in small numbers

- Pangasius (basa fish, stripped catfish, pacific dory...)



then ponds (typically ranging from 1 000 to 10 000 m<sup>2</sup>) are of simple design and are sited adjacent to or near river tributaries. Producers aerate the ponds and exchange water for several hours daily during the culture period by tidal exchange and pumping; this reduces muddy of colour and produces whiter flesh. Despite recommendations from government extension agencies to stock 20-40 fish/m<sup>2</sup>, intensive monoculture ponds are usually stocked at 40-60/m<sup>2</sup>, with some growers stocking even higher. Yields reach 250-300 tonnes/ha/crop, exceptionally reaching 500 tonnes/ha/crop in ponds. Striped catfish reach 1-1.5 kg after 6 months or less, depending on the size of fingerlings stocked. Today (2010) few striped catfish monoculture grow-out producers can be described as 'small-scale' because the minimum harvest from a single pond is usually 50 tonnes or more.



The Mekong Giant Catfish is in the same family as the basa and striped catfish. Pangasius. Like its name says it lives in the Mekong river. It is known to be the fastest growing fish and can increase its body weight 400 x in 4 months. It can reach a weight of 440 lbs in 5 yrs. Its status in the wild is in serious trouble and dams are being made on the Mekong that could threaten its survival in the wild. In the past maybe 20 fish were caught annually near the golden triangle but some years as little as 1 fish have been harvested recently.

For instance, a century ago, the Mekong Giant Catfish was found along the entire length of the river from Vietnam to southern China. Since then, however, populations have dropped precipitously. Scientists estimate that the total number of Mekong Giant Catfish has decreased about 90% in just the past two decades.

WWF recently helped broker a voluntary ban on this species with Thai fishers. In Laos as early as 1890, a large fishery developed for the Mekong Giant Catfish but by 1940, declines were observed in northeast Thailand.

There are some people farming them. They need lots of space. Fry are becoming more available as people have figured out how to breed them. The key is that the mother breeders need to be at least 13 yrs old. Makes it a bit difficult to find broodstock and plan that far in advance. The meat is similar to swordfish. Many people sell a hybrid of the common pangasius crossed with the giant Mekong catfish and these



# Important things to consider in making fish farming sustainable

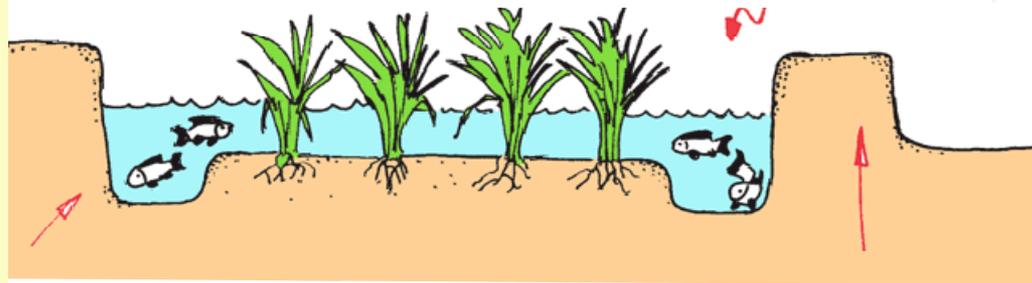
- What species do we choose to raise?
  - efficient converters of feed and preferably fish that feed low on the food chain that don't depend on fish meal in their diet.
- How do we raise those species?
  - Extensively, Semi Intensively or Intensively?

# Rice and Fish systems



Benefits:  
pest management, 15% increase in yields, fish help aerate by their swimming and foraging, bonus of fish, raised dike can be used for planting fruit trees, better water management

Risks:  
pesticides, predation, theft, problem with water shortages, more management





- Chicken and Fish

- rate of 250 chickens per rai pond (1500 birds for a hectare pond)

Delicious™ and a  
Crownmark  
are marks of the  
Delicious™ chicken.

- Chicken and Fish

- rate of 250 chickens per rai pond (1500 birds for a hectare pond)

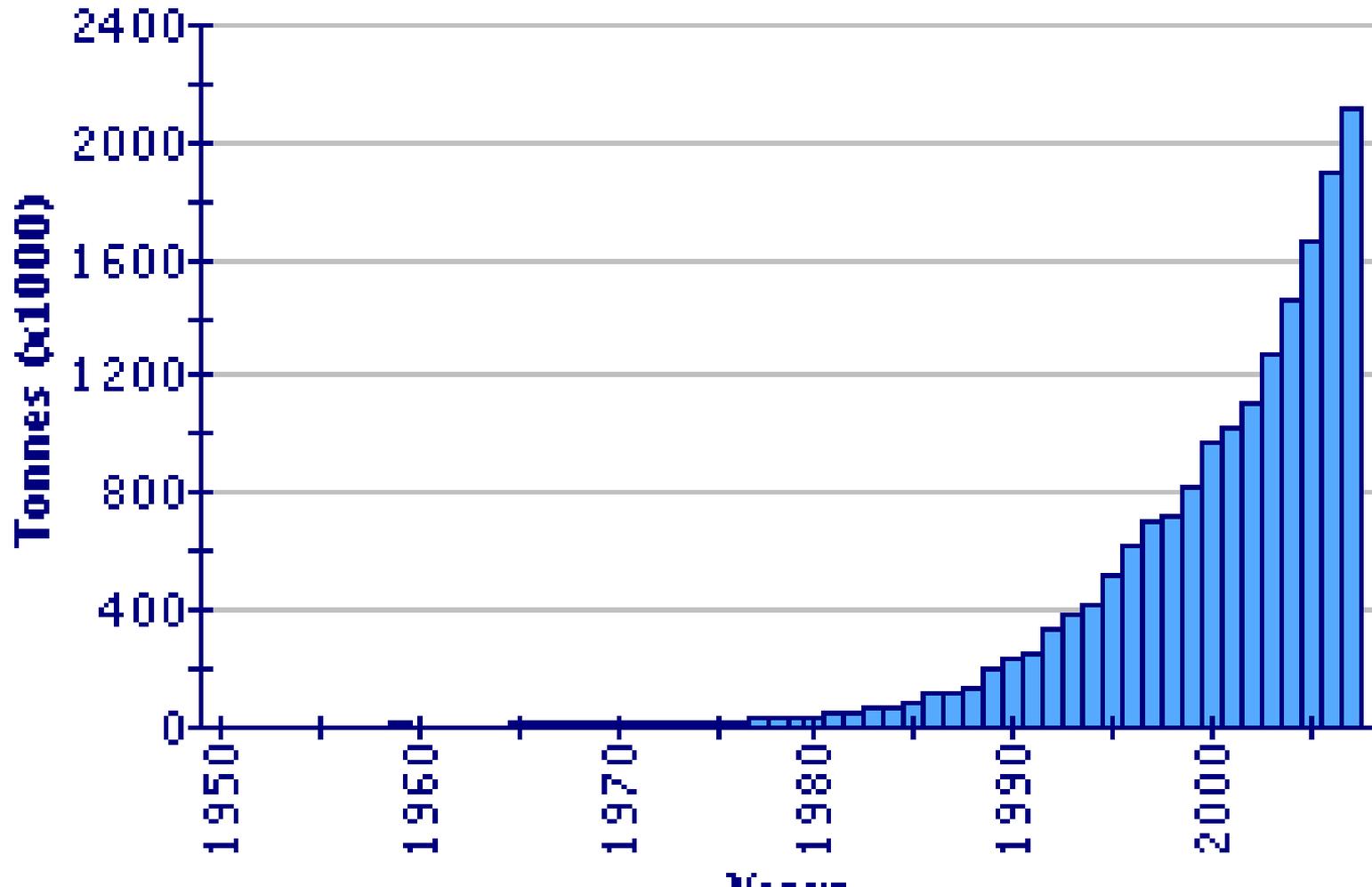
Deloitte™ and a  
Company  
are needed to see this picture.

You would need about 30 pigs per rai pond to get this same rate of N-P-K (186 pigs/hectare pond area)

If you used inorganic fertilizer you would need 30 kg/rai/week

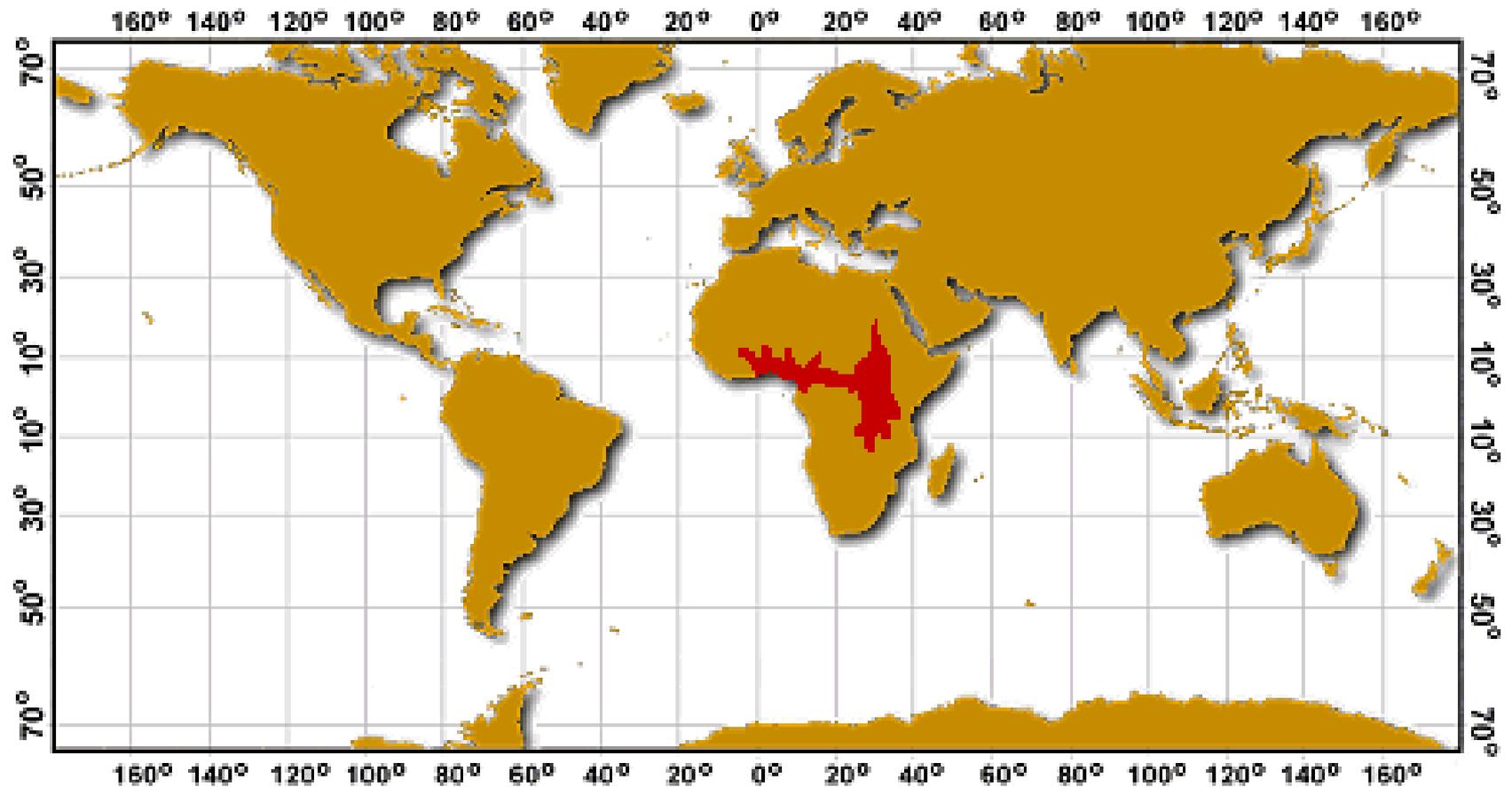
**Deloitte™ and a  
company  
are excited to see this picture.**

# Global Production of Tilapia

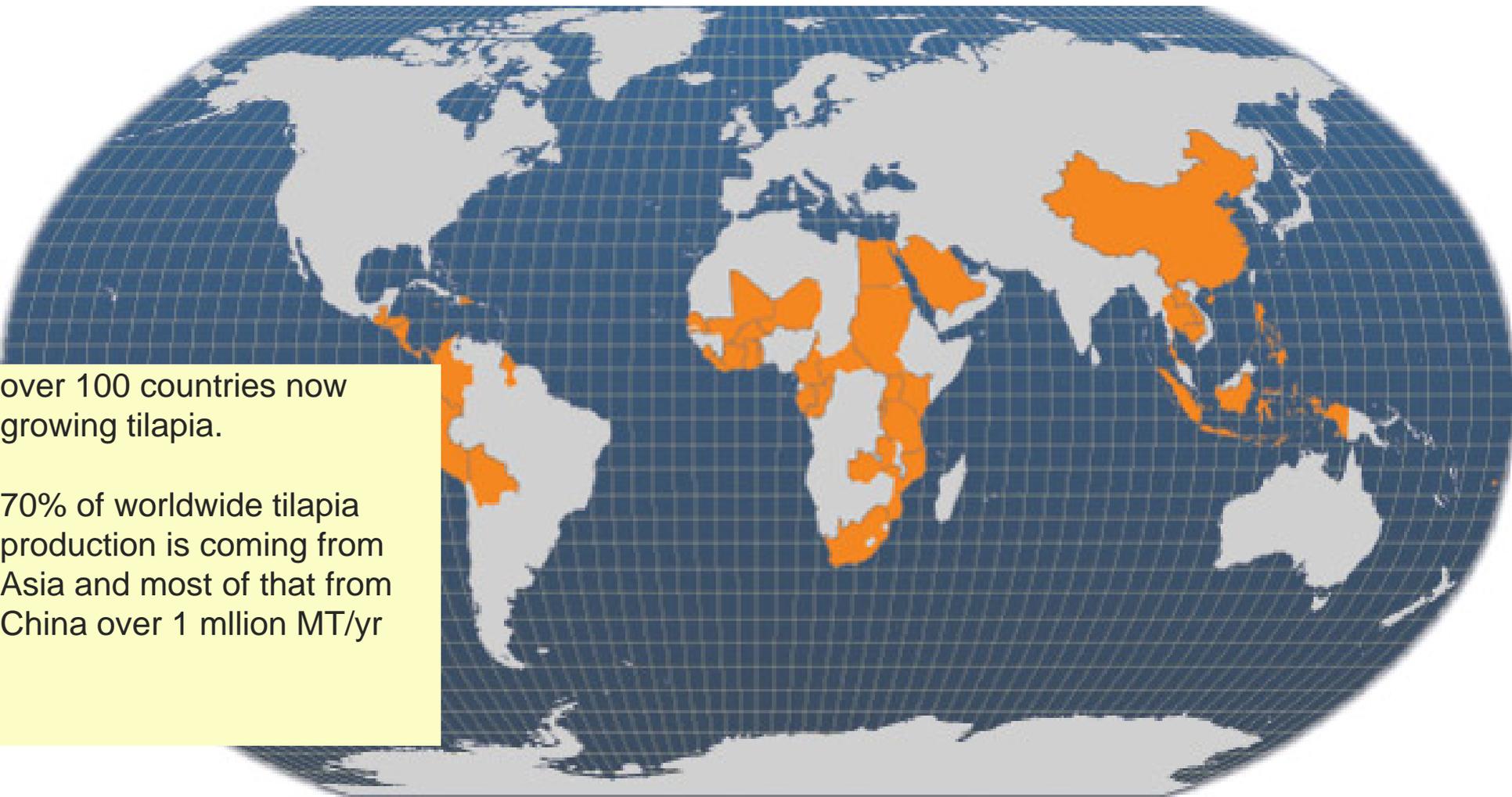


# Natural Distribution of the Nile Tilapia

taken from FAO factsheet



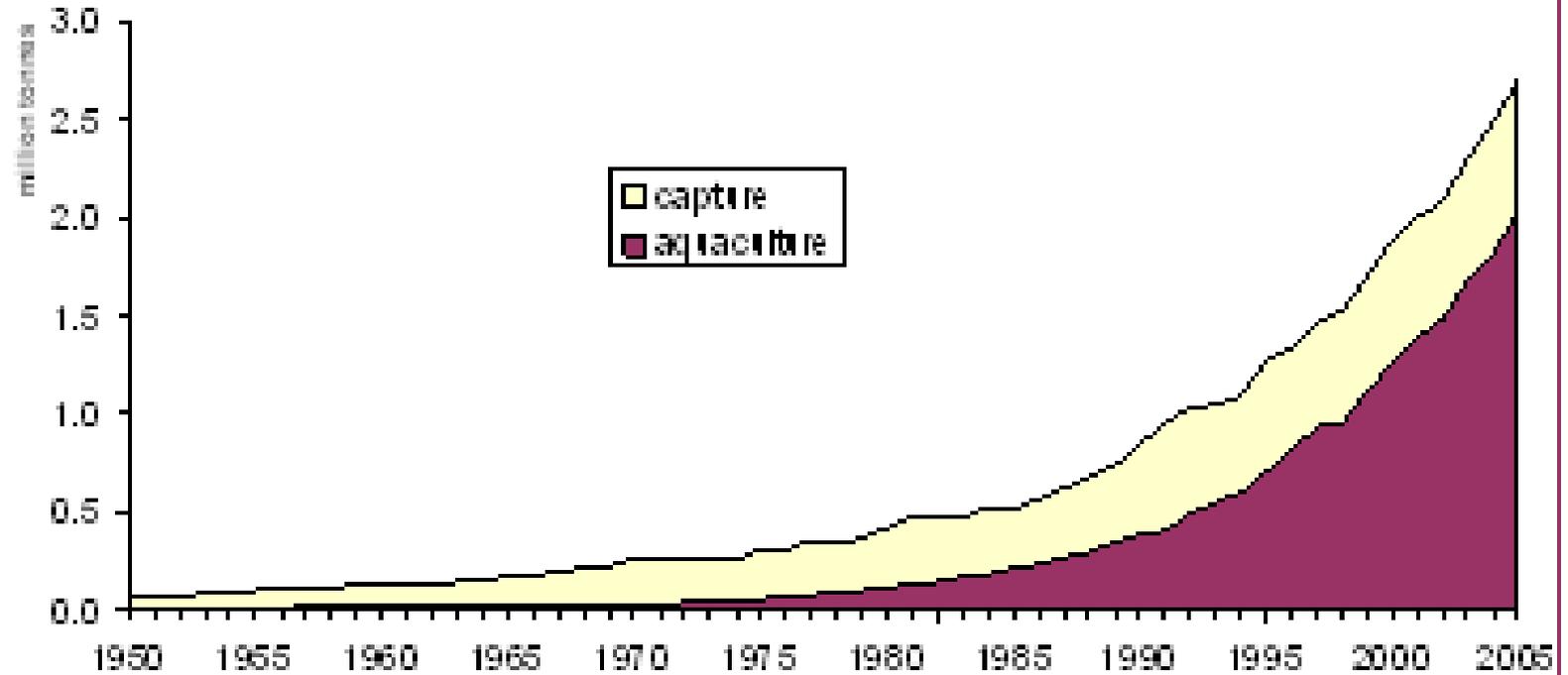
# Main tilapia producing countries



over 100 countries now growing tilapia.

70% of worldwide tilapia production is coming from Asia and most of that from China over 1 million MT/yr

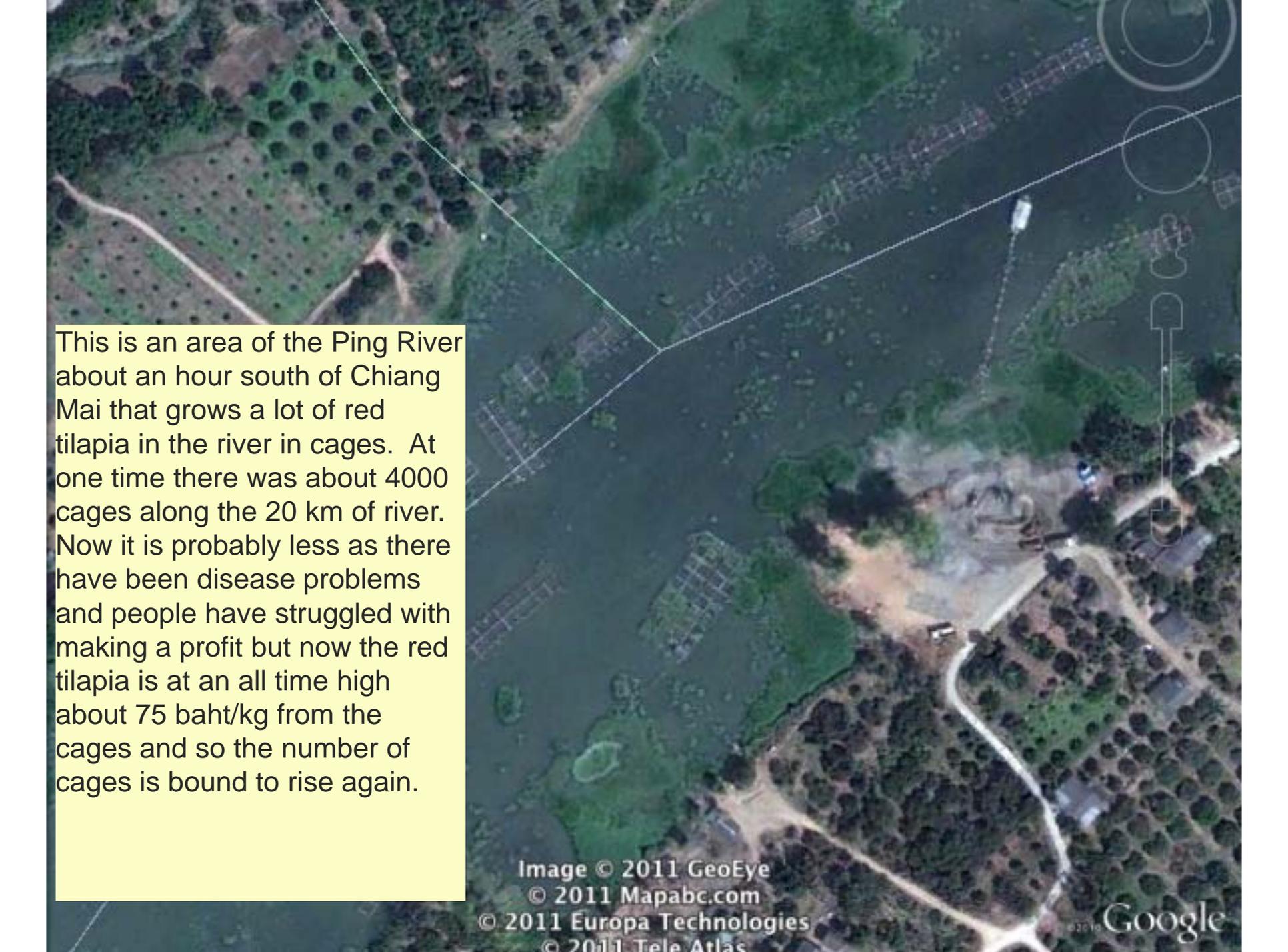
# World tilapia production



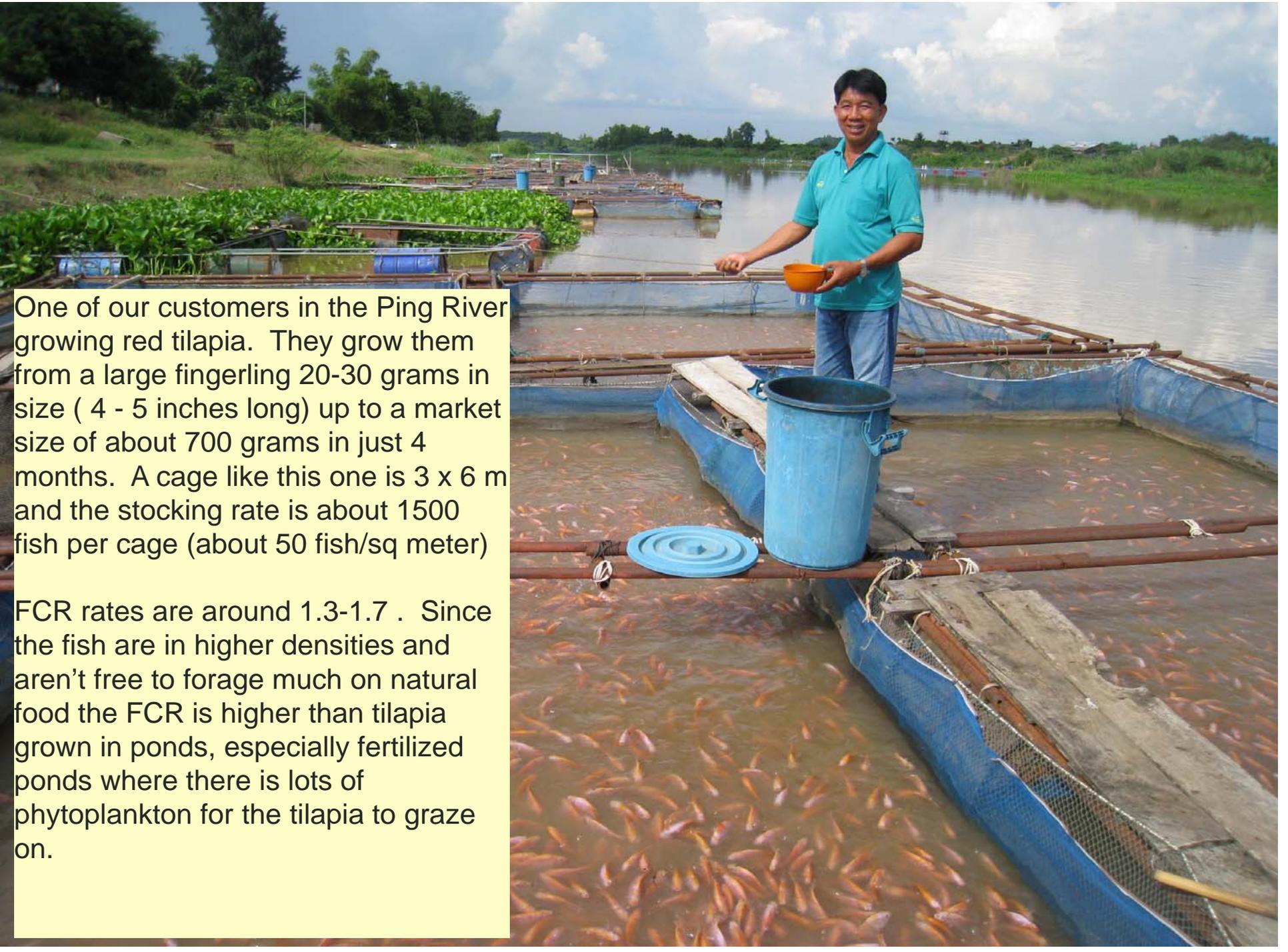
# Integrated pig-fish farm in NE Thailand

QuickTime™ and a  
H.264 decompressor  
are needed to see this picture.

**Deloitte™ and a  
company  
are excited to see this picture.**

An aerial satellite photograph showing a wide river with numerous rectangular fish cages floating on its surface. The surrounding land is a mix of green fields, some with circular patterns, and brownish areas. A road and some buildings are visible on the right side of the river. The image is overlaid with a semi-transparent yellow text box on the left and various map interface elements on the right and bottom.

This is an area of the Ping River about an hour south of Chiang Mai that grows a lot of red tilapia in the river in cages. At one time there was about 4000 cages along the 20 km of river. Now it is probably less as there have been disease problems and people have struggled with making a profit but now the red tilapia is at an all time high about 75 baht/kg from the cages and so the number of cages is bound to rise again.



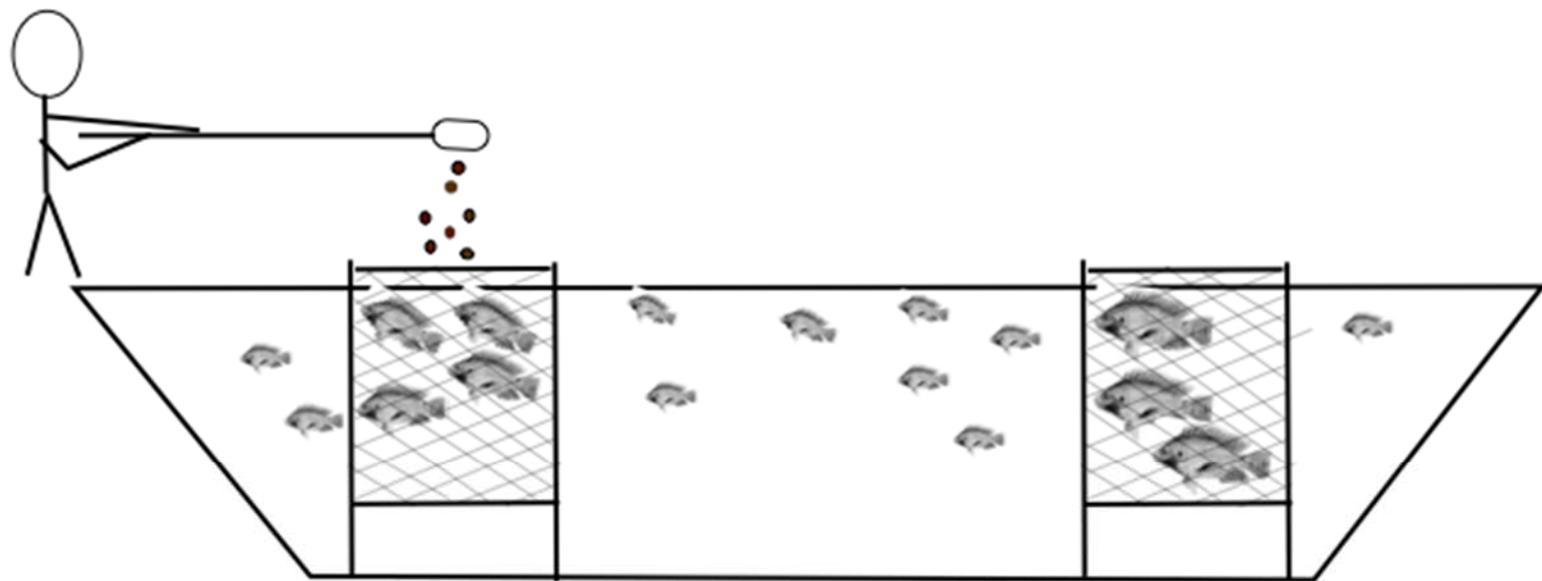
One of our customers in the Ping River growing red tilapia. They grow them from a large fingerling 20-30 grams in size ( 4 - 5 inches long) up to a market size of about 700 grams in just 4 months. A cage like this one is 3 x 6 m and the stocking rate is about 1500 fish per cage (about 50 fish/sq meter)

FCR rates are around 1.3-1.7 . Since the fish are in higher densities and aren't free to forage much on natural food the FCR is higher than tilapia grown in ponds, especially fertilized ponds where there is lots of phytoplankton for the tilapia to graze on.

some places are having environmental problems from too many cages in a body of water. Lake Taal in the Philippines is an example. They have big fish kills annually like this one that happened to milk fish in cages after a big change in temperature and people thought it triggered low oxygen levels.



## Tilapia fattening in cages

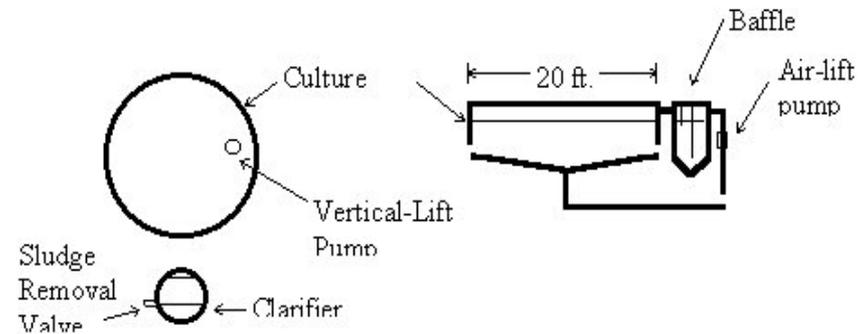


**QuickTime™ and a  
decompressor  
are needed to see this picture.**

**QuickTime™ and a  
decompressor  
are needed to see this picture.**

**QuickTime™ and a  
decompressor  
are needed to see this picture.**

# Intensive green water production in tanks



*Top and side view of greenwater tank culture system.*

# of tilapia

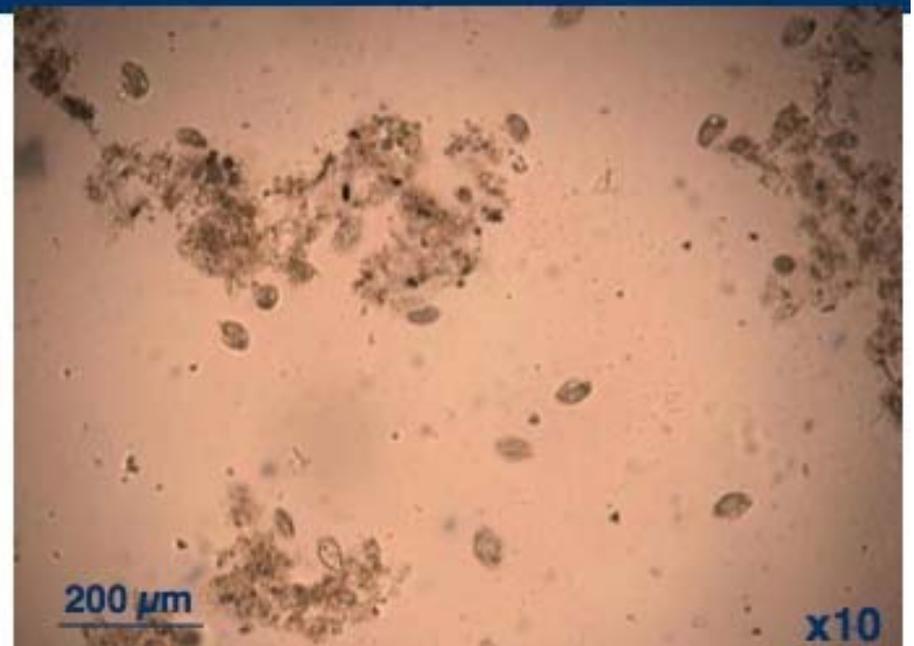
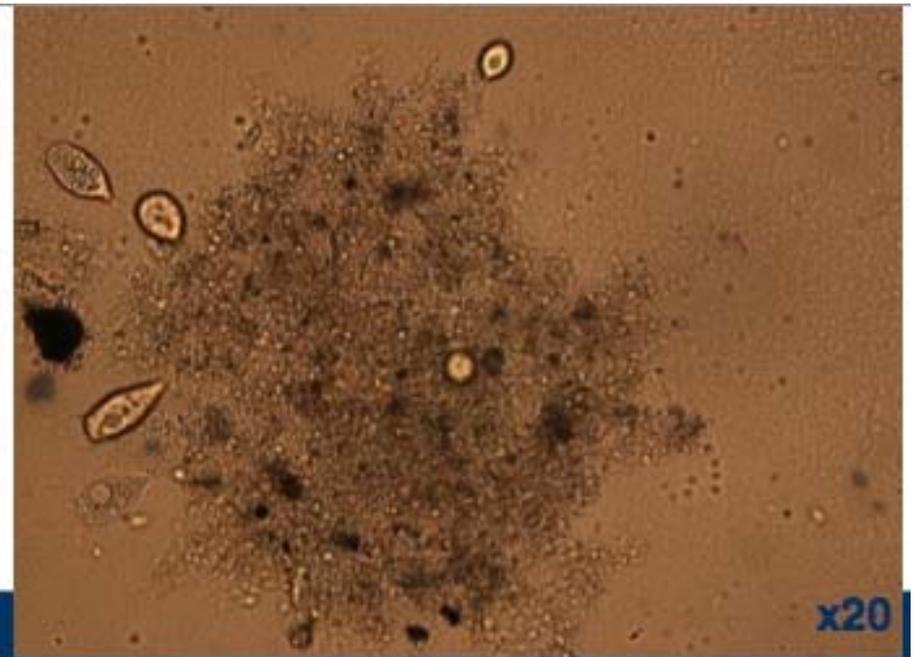
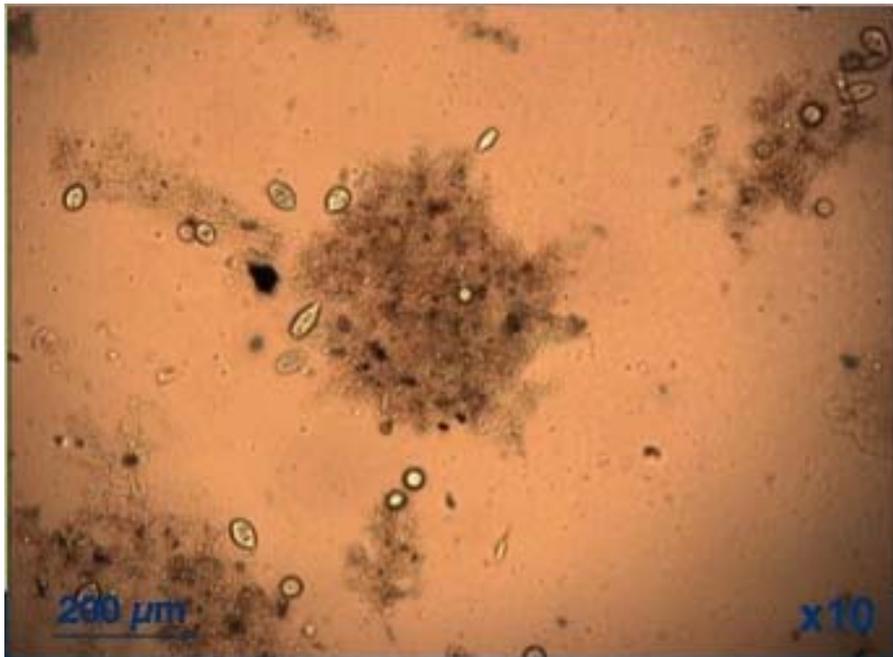
floc is made up a bacteria, protozoa feeding on suspended organic matter (unused fish feed, feces)

tilapia might be able to utilize 25% of feed but when a floc system is used they are able to eat it again by filter feeding the floc. Utilization then reaches up to 50%

Carrying capacity can be 20-30 kg tilapia/cubic meter

Bacteria is very high in protein 60% and so good growth is achieved by this intensive method





# University of Virgin Islands Aquaponics











Is this system viable?

Set up cost 45,000 Baht  
1500

Monthly cost to run the system

Electricity 950 Baht

1000 watt water pump for recirculation

1500 watt blower for aeration of fish and plant roots

Fish feed: FCR 1.7

Meaning  $18.3 \text{ baht/kg} \times 1.7 = 31 \text{ baht/kg}$  feed cost

Fingerling cost of red tilapia 4.5 baht/4 inch fingerling

1 tank sold per month

$10 \times 500 \text{ gram} \times 80 \text{ baht/kg} = 2000 \text{ baht}$

Cost of fingerlings = 4.5 baht per fish

Feed investment (FCR 1.7) = 15 baht

17 baht per fish investment  $\times 50 = 850 \text{ baht/tank}$ .

Electricity cost per tank for a 4 month cycle = 950 baht

Income from vegetables?? need to be a vegetable that  
fetches a decent price in Thailand





# Barrel-ponics (Travis Hughey)

QuickTime™ and a  
decompressor  
are needed to see this picture.

**QuickTime™ and a  
decompressor  
are needed to see this picture.**

QuickTime™ and a  
decompressor  
are needed to see this picture.

QuickTime™ and a  
decompressor  
are needed to see this picture.

**QuickTime™ and a  
decompressor  
are needed to see this picture.**

**QuickTime™ and a  
decompressor  
are needed to see this picture.**

# How to select species and the system?

- Cost of land or land available
- Market prices of fish, availability of fry, desired species in market
- Cost of water
- Cost of production (labor, feed...)
- Local climate
- local resources to manage the system (equipment, human resources)

# Why is Tilapia considered the most important Aquaculture species for the 21<sup>st</sup> Century?

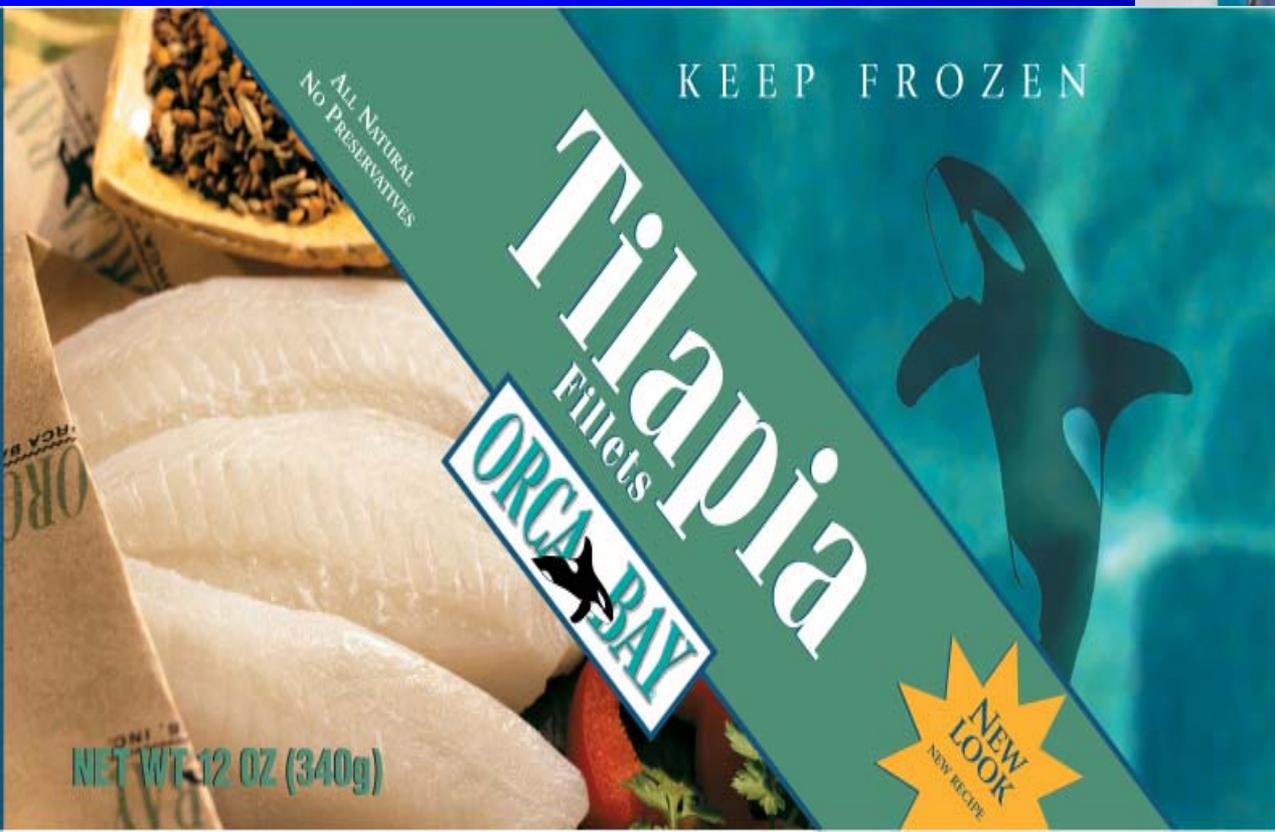
- Now grown in over 100 countries, estimated production for 2010 at over 3 million metric tons. (659,000 t in 1995)
- Low FCR, omnivorous, phytoplankton filter feeder
- High tolerance for many environments
- Can be grown extensively to intensively
- Good quality meat, little bones, high moisture content, neutral flavor



# Improvements in packaging

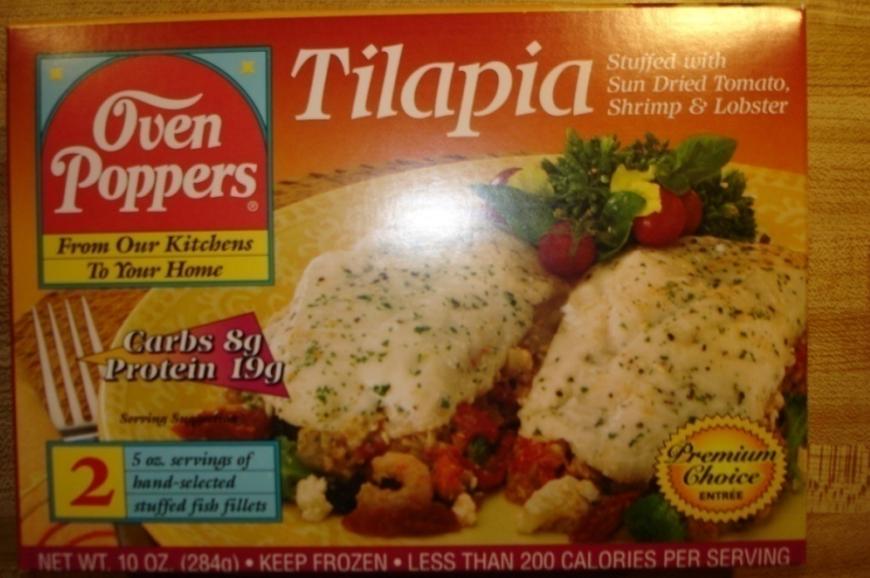


# IQF Fillets in re-sealable packages









# Tilapia Orange Juice

h Fat 5
Value*
1%
0%
0%
0%
13%
6g 9%
0%



**Ingredients:** 100% Pure pasteurized orange juice and MEG-3<sup>®</sup>\* (fish oil and fish gelatin).

Contains tilapia, sardine and anchovy.

\*Ingredient not found in regular orange juice.

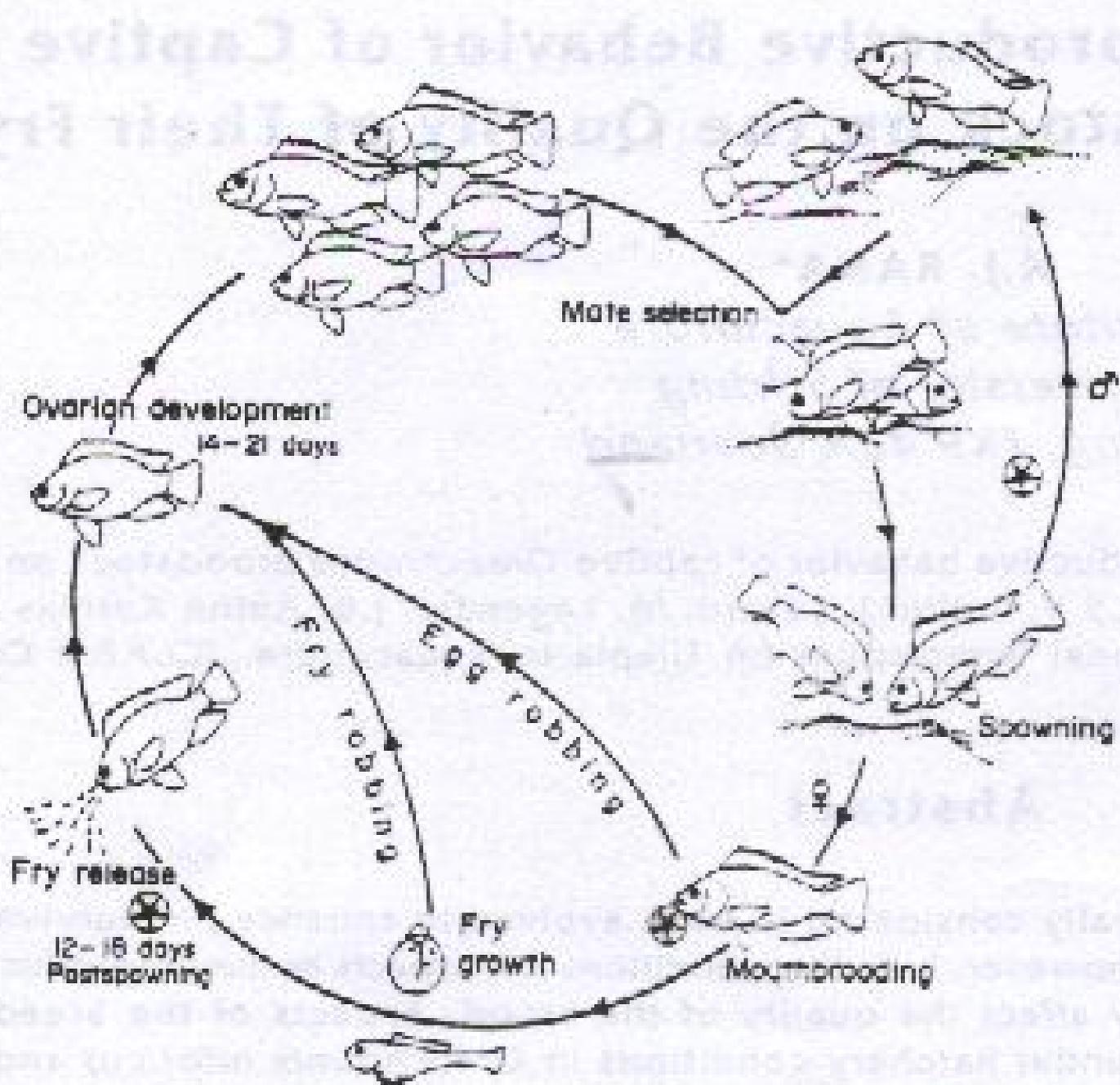


MEG-3<sup>®</sup> and trust the source<sup>®</sup> are

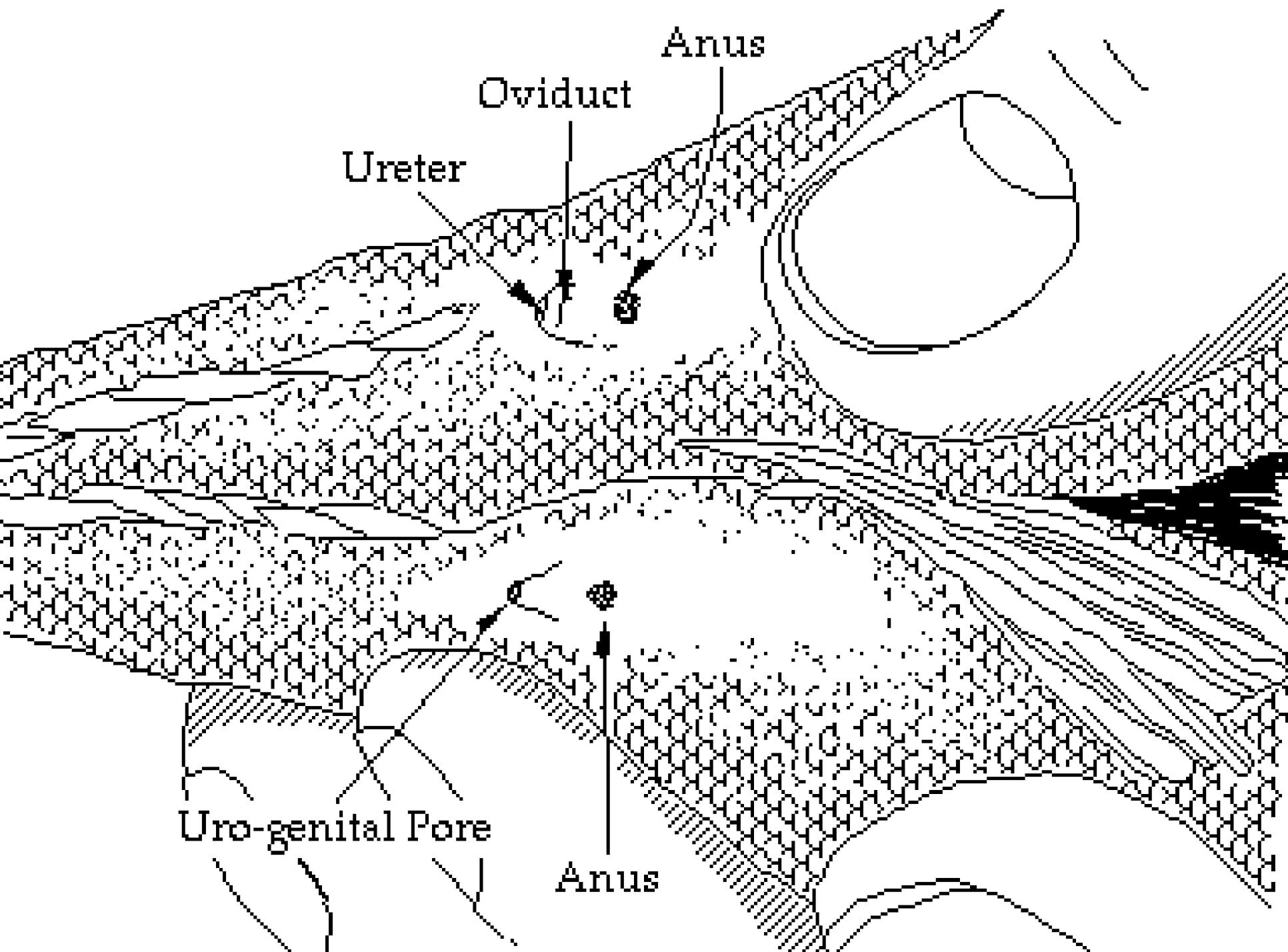
# Why is Tilapia considered the most important Aquaculture species for the 21<sup>st</sup> Century?

- Now grown in over 100 countries, estimated production for 2010 at over 3 million metric tons. (659,000 t in 1995)
- Low FCR, omnivorous, phytoplankton filter feeder
- High tolerance for many environments
- Can be grown extensively to intensively
- Good quality meat, little bones, high moisture content, neutral flavor
- Ease of reproduction (breeds year around)















มูลนิธิส่งเสริมชีวิตภาคเหนือ  
Northern Thai Foundation for Enablement

โครงการฟาร์มเลี้ยงไหมพัฒนา  
Chiang Mai Development Farm

บ่อ 1 1,000 ตรม. บ่อ 2 2,500 ตรม. บ่อ 3 1,200 ตรม. บ่อ 4 1,600 ตรม. บ่อ 5 1,800 ตรม. บ่อ 4 1,600 ตรม.

บ่อ 11 2,500 ตรม. บ่อ 10 3,000 ตรม. บ่อ 9 1,800 ตรม. บ่อ 8 2,300 ตรม. บ่อ 7 1,200 ตรม.

โรงพัก

บ่อ 12 1,000 ตรม. บ่อ 13 1,700 ตรม. บ่อ 14 1,500 ตรม. บ่อ 15 1,500 ตรม. บ่อ 16 1,000 ตรม.

บ่อ 22 1,900 ตรม. บ่อ 21 1,900 ตรม. บ่อ 20 1,900 ตรม. บ่อ 19 1,900 ตรม. บ่อ 18 1,200 ตรม. บ่อ 17 1,200 ตรม.

โครงการอนุบาลปลา

บ่อ 2 700 ตรม. บ่อ 4 700 ตรม.  
บ่อ 1 700 ตรม. บ่อ 3 700 ตรม. บ่อ 5 300 ตรม.  
บ่อแปลงเพศ บ่อ 6 700 ตรม.  
บ่อ 9 700 ตรม. บ่อ 8 700 ตรม. บ่อ 7 700 ตรม.















มูลนิธิส่งเสริมชีวิตภาคเหนือ  
Northern Thai Foundation for Enablement

โครงการฟาร์มเชิงนิเวศใหม่พัฒนา  
Chiang Mai Development Farm

บ่อ 15  
1,500 ตรม.

บ่อ 18  
1,500 ตรม.

บ่อ 17  
1,500 ตรม.

บ่อ 14  
2,000 ตรม.

บ่อ 12  
1,500 ตรม.

บ่อ 10  
1,000 ตรม.

บ่อ 8  
1,200 ตรม.

บ่อ 13  
1,700 ตรม.

บ่อ 11  
1,000 ตรม.

บ่อ 9  
1,000 ตรม.

บ่อ 1  
1,700 ตรม.

โรงพิก

บ่อ 4  
1,000 ตรม.

บ่อ 6  
1,000 ตรม.

โรงผสมอาหาร

บ่อ 2  
1,700 ตรม.

บ่อ 3  
1,500 ตรม.

บ่อ 5  
1,000 ตรม.

บ่อ 7  
1,200 ตรม.











2-8-5-21-2  
21-2

2-5-8-21-2  
21-2

2-8-5-21-2  
21-2





















- Use nursery ponds for 2 to 3 months at stocking densities of 35-40 fish/m<sup>2</sup>

- Nursery nets

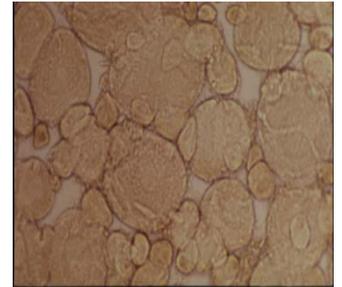
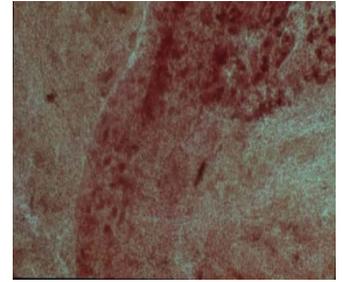


# How can aquaculture help rural development?

- 1) Fish farming doesn't have to be the farmers only occupation but works well as a secondary livelihood.
- 2) Aquaculture requires little labor for most of the growing period and if green water culture is done sometimes requires only weekly fertilizer inputs.
- 3) Tilapia are small in size compared to livestock and thus are easier to sell.
- 4) Fish farming can be combined with other livestock and reuse wastes efficiently.













# How can we improve farmer's profits?

## 1. Sex manipulation

Farmers claim to get up to 10 x the profit with SRT over mixed sex tilapia

# How can we improve farmer's profits?

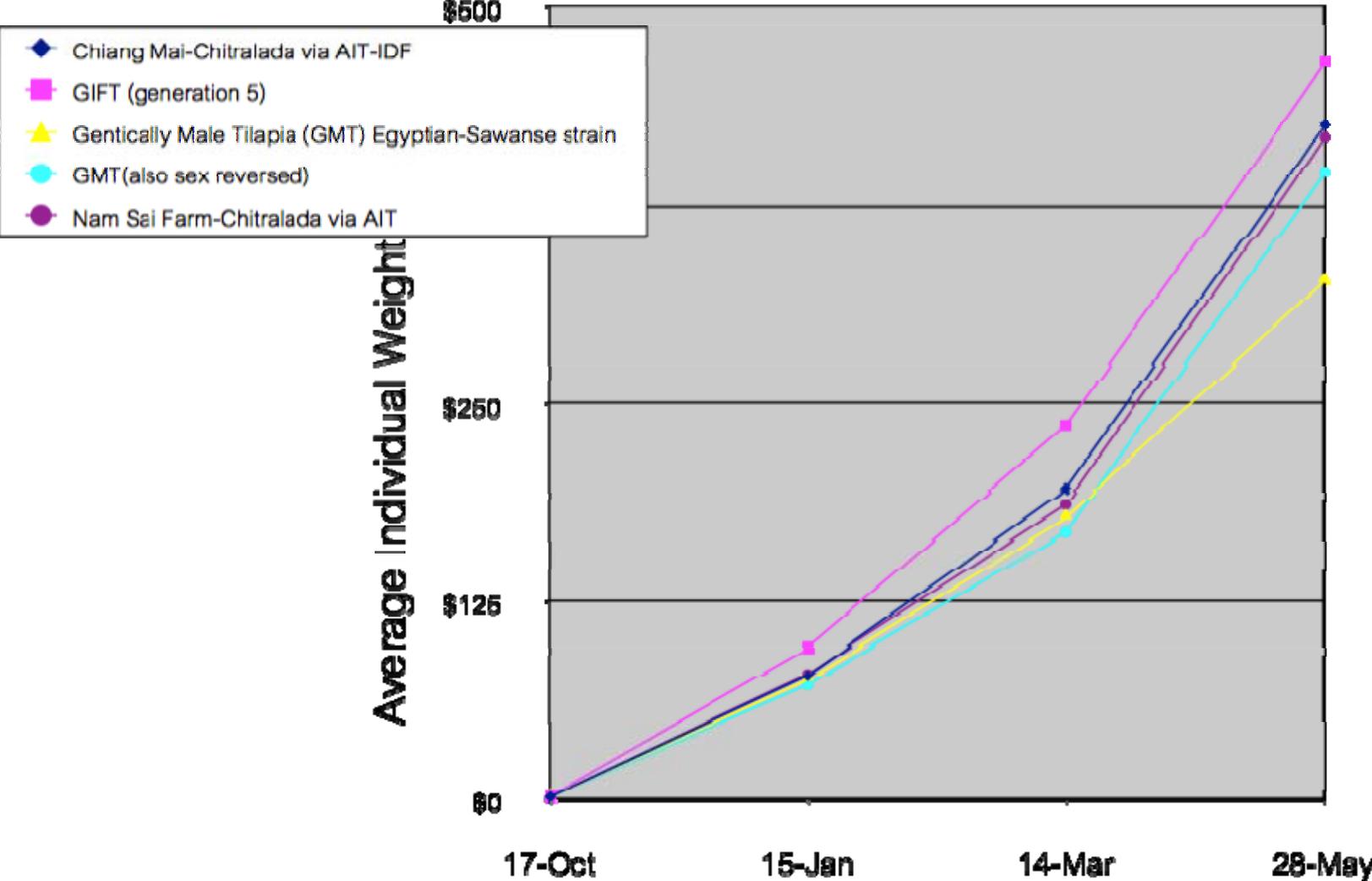
## 1. Sex manipulation

Farmers claim to get up to 10 x the profit with SRT over mixed sex tilapia

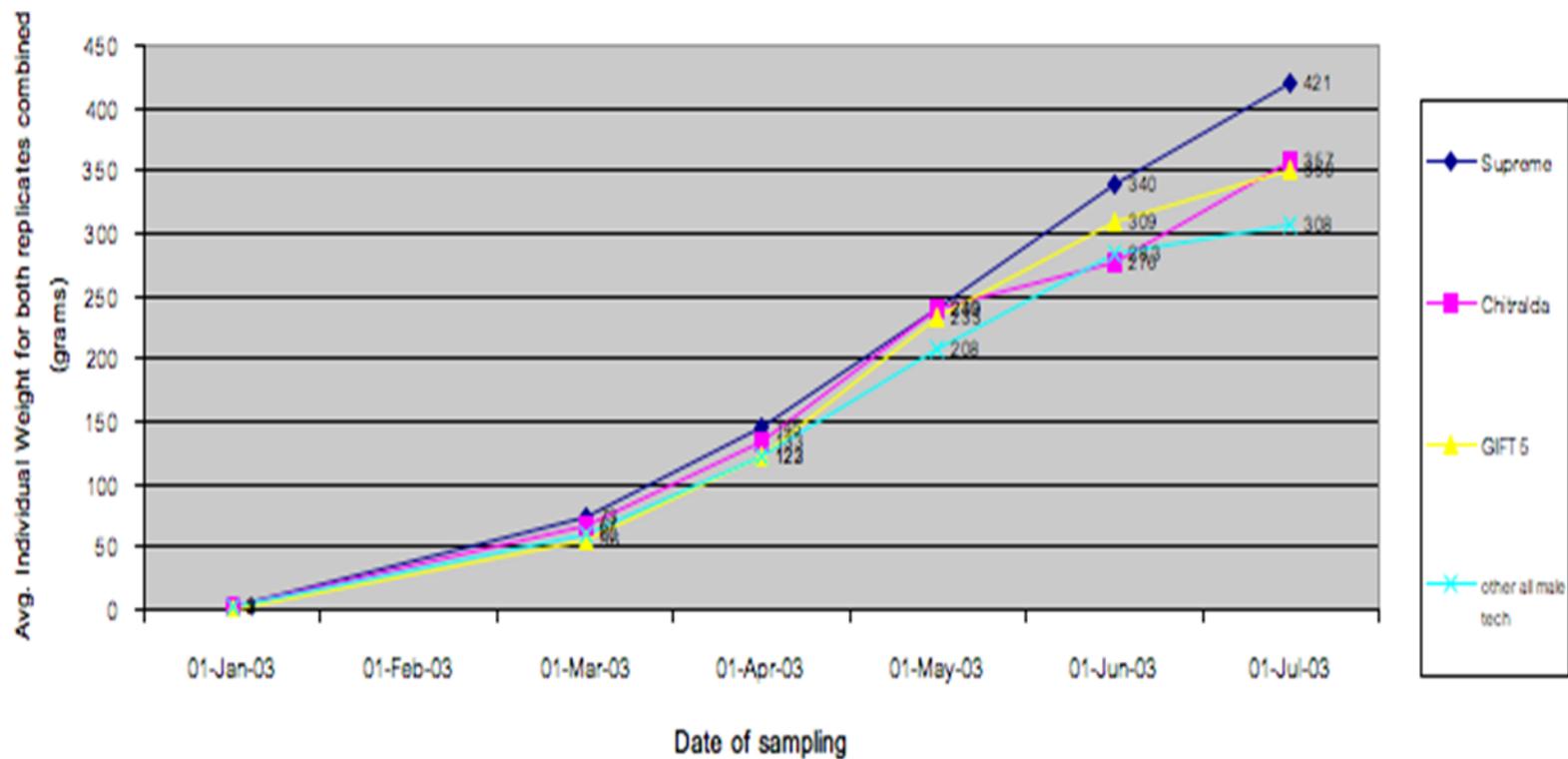
## 2. Genetic Improvement



# Grow out Experiment for Various *O. niloticus* Strain



Avg. for two Replicates in Growth Trials of 4 *O. niloticus* strains in Chiang Mai







Б.С.К.9  
С.О.И.К.9



# How can we improve farmer's profits?

## 1. Sex manipulation

Farmers claim to get up to 10 x the profit with SRT over mixed sex tilapia

- Genetic Improvement

## 2. Increase Total Biomass by Higher Stocking Densities

# How can we improve farmer's profits?

## 1. Sex manipulation

Farmers claim to get up to 10 x the profit with SRT over mixed sex tilapia

- Genetic Improvement

## 2. Increase Total Biomass by Higher Stocking Densities

## 4. Use more cost effective feeding strategies

# How can we improve farmer's profits?

## 1. Sex manipulation

Farmers claim to get up to 10 x the profit with SRT over mixed sex tilapia

- Genetic Improvement

## 2. Increase Total Biomass by Higher Stocking Densities

## 4. Use more cost effective feeding strategies

## 5. Use optimal culture conditions