Development and outlook of Egyptian aquaculture
(mode of development - regional & global perspective – challenges - outlook)

Abdel Rahman El Gamal, PhD
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• Fish consumption, trade and quality
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Fishery resources in Egypt
Fishery resources in Egypt

Mediterranean, Red Sea, River Nile & lakes are the main sources for capture fisheries.

Total fish production from all resources reached 1,454,401 tons in 2013.

Aquaculture contribution represents 75.6% of total fish production in 2013.

Egyptian aquaculture is the 7th globally.
Aquaculture development
World Bank Mission (1978): findings and recommendations

Potential acreage for aquaculture: 23,400 feddan*
Potential production from aquaculture 35,000 tons
Average production: 1.5 ton/feddan

- Tilapia 50%
- Mullet 30%
- Carps 20%

* Feddan = 4200 m²

The production of aquaculture reached about 30 folds of estimated production
However:
Average production from earthen ponds is almost as previously estimated
Species composition in the present is close to what was estimated
Aquaculture development

Building upon the World Bank mission, it became obvious there was a good aquaculture opportunity in Egypt.

The practice started with the use of traditional practices whereas inputs and so outputs were low.

No use of Nile waters, no use of agricultural land.

Capacity building and international experience played a major role in the development.

Rapid then remarkable development in aquaculture took place in mid 1990s.

Development has been credited to the all-male tilapia as well as to the commercial feed. Of course the well-trained personnel were behind all that.
Features of Egyptian aquaculture
Contribution of aquaculture and fishery in total production (2002-2013)

- Aquaculture: > 50%
- Fishery: > a million ton


Total production values from 2002 to 2013:
- 2002: 800000
- 2003: 900000
- 2004: 1000000
- 2005: 1100000
- 2006: 1200000
- 2007: 1300000
- 2008: 1400000
- 2009: 1500000
- 2010: 1600000
- 2011: 1700000
- 2012: 1800000
- 2013: 1900000

Graph shows a steady increase in total production with aquaculture contributing more than 50% and reaching over a million ton by 2013.
## Egyptian aquaculture
(Global perspective – Top Ten - 2011/2013)

<table>
<thead>
<tr>
<th>Country</th>
<th>Production (ton)</th>
<th>2011</th>
<th>Production (ton)</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>38,621,269</td>
<td></td>
<td>43,549,738</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>4,573,465</td>
<td></td>
<td>4,549,607</td>
<td></td>
</tr>
<tr>
<td>Vietnam</td>
<td>2,845,600</td>
<td></td>
<td>3,819,732</td>
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</tr>
<tr>
<td>Indonesia</td>
<td>2,718,421</td>
<td></td>
<td>3,207,200</td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td>1,523,759</td>
<td></td>
<td>1,859,808</td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>1,138,797</td>
<td></td>
<td>1,247,865</td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td>1,008,049</td>
<td></td>
<td>1,056,955</td>
<td></td>
</tr>
<tr>
<td>Egypt</td>
<td>986,820</td>
<td></td>
<td>1,097,544</td>
<td></td>
</tr>
<tr>
<td>Chile</td>
<td>954,845</td>
<td></td>
<td>1,033,206</td>
<td></td>
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<tr>
<td>Myanmar</td>
<td>816,820</td>
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<td>929,180</td>
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</table>
Features of Egyptian aquaculture
(narrow production basket)

<table>
<thead>
<tr>
<th>Species</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2013</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>ton</td>
<td>%</td>
<td>ton</td>
<td>%</td>
<td>ton</td>
</tr>
<tr>
<td>Tilapia</td>
<td>557049</td>
<td>60.6</td>
<td>610617</td>
<td>61.9</td>
<td>768752</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>635843</td>
</tr>
<tr>
<td>Mullet</td>
<td>116029</td>
<td>12.6</td>
<td>114001</td>
<td>11.6</td>
<td>129651</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>116151</td>
</tr>
<tr>
<td>Carps</td>
<td>191721</td>
<td>20.8</td>
<td>203662</td>
<td>20.6</td>
<td>67065</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>294047</td>
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<tr>
<td>Others</td>
<td>54786</td>
<td>06.0</td>
<td>58540</td>
<td>05.9</td>
<td>52268</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>51503</td>
</tr>
<tr>
<td>Total</td>
<td>919585</td>
<td>100</td>
<td>986820</td>
<td>100</td>
<td>1017736</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1097544</td>
</tr>
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</table>

For decades, Egypt ranked second in regard to global tilapia production (after China); in 2013 Indonesia took over and hence Egypt is the 3rd

Others include marine finfish, marine shrimp, African catfish, and eels
Composition of others in 2012 & 2013 (52268 & 51503 tons)

2012:
- Bass & bream: 28604 tons
- Meagre: 8319 tons
- Shrimp: 14236 tons
- Catfish & others: 1109 tons

2013:
- Bass & bream: 26865 tons
- Meagre: 5856 tons
- Shrimp: 4889 tons
- Catfish & others: 13893 tons
Tilapia production overview (2013)

Compared with tilapia performance in 2012

The contribution of tilapia in Egyptian fish production is going down. Suggested causes: production economics – emerging bacterial disease.
Tilapia is a limiting species due to its intolerance to cold – Because of that:

- Growing season starts when temperature warms up (April)
- Peak of harvesting (October – December/January)
- Farms which have warm ground water enjoy flexible management systems and all-year production if justified
- Greenhouses (hatcheries): Starting activities during winter months and provide tilapia fry in April when outdoor temperature warms up
- Open tilapia hatchery –in hapas- operates during late spring and ends by end fall
Fish farming and tilapia

Tilapia (harvesting)

Over-wintering of tilapia

All-year round tilapia farming (well water)
## Total fish production in selected years (ton)

<table>
<thead>
<tr>
<th>Year</th>
<th>2003</th>
<th>2005</th>
<th>2007</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
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</thead>
<tbody>
<tr>
<td>Fishery</td>
<td>431123</td>
<td>349553</td>
<td>372491</td>
<td>387398</td>
<td>385209</td>
<td>375354</td>
<td>354237</td>
<td>356858</td>
</tr>
<tr>
<td>Aquaculture (%/total)</td>
<td>444867 (50.78)</td>
<td>539747 (60.69)</td>
<td>635517 (63.04)</td>
<td>705490 (64.55)</td>
<td>919585 (70.47)</td>
<td>986820 (72.44)</td>
<td>1017738 (74.18)</td>
<td>1097544 (75.46)</td>
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<tr>
<td>Total</td>
<td>875990</td>
<td>889300</td>
<td>1008008</td>
<td>1092888</td>
<td>1304794</td>
<td>1362174</td>
<td>1371975</td>
<td>1454401</td>
</tr>
</tbody>
</table>

**Source:** General Authority for Fish Resources Development, Yearbook statistics
Since mid-1990s, aquaculture witnesses periods of sharp to slight increase

**BUT**

Never decreased till now

Production economics is the key factor in determining the mode of production and so the degree of development
Earthen ponds are the main aquaculture producer: 729,921 tons; 72% of total production in 2012.

Any improvement in pond productivity will be significantly felt.

Total acreage of earthen ponds amounted to 287,408 feddans (120,711 hectares) in 2012.

>95% of acreage belongs to private sector.

Almost all suitable land for aquaculture has been taken out (limiting horizontal expansion).

Owned land represents 14% of the total area; the remaining areas are either leased or utilized temporarily for aquaculture.

Productivity varies significantly.

**Earthen ponds:** Will remain the main production system (for economic reasons).
Other aquaculture types

- Intensive farms
- Cages
- Integrated rice-fish
Nile cage aquaculture
Banning/Coming back/Banning

Damietta/Rosetta Branches (banned – lifted)

In sensitive water such as the Nile, unless cage farming practices meet the environmental and public health standards & navigation requirements, its sustainability is questionable.

Silver carp was promoted as friendly fish - However, tilapia remains the species of interest.

In Rayaan - Fayoum

Lifting cages in Rosetta – July/2015
Emerging systems (desert aquaculture)

Advantages:
- All-year production
- A promising system for export
- Usually integrated with other plants and/or livestock

Limitation:
- Sustainability of underground water
- How construction costs

Fresh or Marine
Fish seed collection

The only source for mullet farming (no commercial mullet hatchery – some trials)

Same is true for European seabass and gilthead seabream (few millions are hatchery produced

Collected marine fry fluctuates with a declining trend (148 million in 1990 & 73 million in 2012)

Negligible numbers of seabass, seabream and meagre are collected from the wild (omitted in 2011 statistics)
There is always a debate between fishermen and fish farmers about fry collection.

Fishermen claim the harm on capture fishery due to the collection of wild fry.

Fish farmers claim that higher survival and biomass are achieved in aquaculture facilities.

The value of stocking programs requires validation otherwise biased opinion may develop.
Since 1990, the use of herbicides in the control of aquatic plants in the River Nile and irrigation canals has been banned.

Instead, the use of grass carp, *Ctenopharyngodon idella* has been introduced as a biological control agent.

The Channel Maintenance Research Institute (CMRI) of the Ministry of Water Resources and Irrigation is in charge of the program (seed production and release)- Grass carp seeds are produced in collaboration with governmental hatcheries.

Two components are needed to supplement this program:
- Impact assessment
- Creating awareness and introduce catch and release concept among fishermen
Fish seed production

About 110 tilapia hatcheries operate in the present with the dominance by the private sector. Realistically, actual tilapia fingerlings should exceed **by far** the reported 243 million in 2012.

Fingerlings of carps are produced **mainly** in governmental hatcheries with a total of 157 million in 2012 of three species (common, silver and grass carp).

Most of common carp fingerlings are produced for rice-fish culture.

About 44 million of grass carp fingerlings are produced for the biological control of aquatic plants (in 2012)

Few marine hatcheries are in limited operations (11 million in 2012). Most of the recent increase is credited to shrimp.
Fish feed industry

Fish feed is more directed towards tilapia

A growing industry; (about 500,000 tons at present) produced by feed mills with different capacities and technologies

Most of feed ingredients are imported (about 75%)

Some feed mills have got “Good Manufacturing Practices” standards

Active joint venturing with international companies is now in place

Some feed is exported to Arab and African countries.

Some specialized feed is imported for marine fish/shrimp
Fish consumption, trade and quality
Fish consumption and trade

The Per capita fish consumption in Egypt is close or slightly exceeds the world average (20.5 kg/2012; 19.7 kg/2013). The national strategy aims to maintain the world average from the local production by 2017.

Fish import fills the gap between national production and consumption (390,605 t in 2010, 182,222 t in 2011, 335,000 t in 2012 and 236,000 t in 2013). Foreign exchange rate influences fish importation.

Only a modest quantity of marine capture fishery is exported (9,489 t in 2011 increasing to 15,810 t in 2012 and then 20,450 t in 2013). Most of the exports are Mediterranean fish.
## Fish trade - quantities of fish import & export (ton)

<table>
<thead>
<tr>
<th>Fishery resources</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local production</td>
<td>1067630</td>
<td>1092888</td>
<td>1304794</td>
<td>1362174</td>
<td>1371975</td>
<td>1454401</td>
</tr>
<tr>
<td>Imports</td>
<td>136807</td>
<td>135523</td>
<td>256813</td>
<td>182222</td>
<td>335000</td>
<td>236000</td>
</tr>
<tr>
<td>Exports</td>
<td>6727</td>
<td>7594</td>
<td>10596</td>
<td>9489</td>
<td>15810</td>
<td>20450</td>
</tr>
<tr>
<td>Available for consumption</td>
<td>1197710</td>
<td>1220817</td>
<td>1551011</td>
<td>1534907</td>
<td>1691165</td>
<td>1669951</td>
</tr>
</tbody>
</table>

**Source:** General Authority for Fish Resources Development, Yearbook statistics

Importing cold water fish is required in some markets & needed for smoking
Importing species of production shortage is quite normal (e.g. shrimp)
However, importing tilapia is a real concern
The central fish market “Obor” is located in Cairo. The markets receives fish from various sources (capture fishery, aquaculture and imports).

The wholesale fish market in Kafr El Sheikh has been established to serve the fish trade in the governorate especially about 43.6% of total fish in Egypt in produced in Kakr El Sheikh; out of which 529,064 tons from aquaculture which represents 52.0% of total Egyptian aquaculture (2012). From this market, fish is distributed within and outside the governorate based on demands.

Auctioning is the system practiced in the central/wholesale markets whereas a fixed fee is deducted from the sale transaction against the market service.
Retail fish marketing

Retail shops provide fish to consumers directly. Retail shops vary in size and in fish displayed. Depending on locations, purchasing power and preferences of consumers, fish demand and supply varies.

In coastal areas, marine fish and shell fish will be displayed more compared to the delta regions whereas tilapia and mullet are more common. Retail shops are either clustered in bigger markets or could be individually located where the demand exists. Weekly village markets are very important in fish marketing.

Large supermarkets often display fish of different species & in different types of preparations.
On the road fish sale

It is common to find individuals selling fish along main roads especially close to lakes. Those could be related to fishermen or just individual jobs. Interestingly, many buyers believe more in the freshness of these fishes based on the closeness to the fishery resources.
Quality issues

Quality awareness is steadily developing among producers and consumers over time.

The competition among producers led to new marketing initiatives (e.g. out-of-season marketing).

Improving fish quality is more adopted when associated with economic returns such as live fish marketing.

Media plays important role and may – sometime- discourage fish consumption whether based on true information or on rumors.
Fish processing

The main types of fish processing in Egypt are:

**Salting:** this is mainly applied to mullets (*Mugil* sp.) to meet the peak of demands during the eastern. The sources of mullets for salting are either capture fishery or aquaculture. Few processors label their salted mullet in order to enable the display of their products in supermarkets and also in regional markets. On-boat salting is also done on several species of Lake Nasser catch including *Alestes* sp., *Labeo* sp., *Hydrocynus* sp., and *Eutropius niloticus*. Wild caught sardines are also salted.

**Smoking:** smoking is performed on imported frozen fish of cold water species (herring like species). A trial was done on African catfish and common carp but was never commercialized.

**Filleting:** performed mainly on large-size tilapia and Nile perch from Lake Nasser and few of Red Sea species such as grouper. Fish fillets (fresh/frozen) aim to meet market demands as well as to achieve efficient transportation to target markets.
Issues of Concerns
## Limitation of natural resources

<table>
<thead>
<tr>
<th>Water</th>
<th>Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe competition on water use especially the per capita water consumption is 680 m$^3$/year (1000 m$^3$/year is the water poverty limit). Agricultural crops enjoy priority over aquaculture in regard to water use. There is some of unutilized water resources (under-ground, brackish, marine).</td>
<td>Almost all suitable land for fish culture are being already utilized as fish farms. Converting the temporarily fish farms into agriculture after salt washing –if happened- would significantly reduce the acreage of fish farms and so fish production. Desert when used for aquaculture requires much higher investments.</td>
</tr>
</tbody>
</table>
Legislations on the use of natural resources

**Water**

With the exception of freshwater hatcheries, farms are not entitled to use river waters.

Only agricultural drainage water is allowed in fish farms. Ensuring that water should be safe.

Even though the use of brackish water in northern delta is encouraged, roads, power and other utilities are needed.

**Land**

The lease term was five years and then ten years. Because most of fish farms are on leased lands, longer lease term encourages the investments as well as benefitting of available credit lines. Recently, the lease term has been extended to 25 years conditioned to good farming practices.

Aquaculture should not be practiced over agricultural land. Hence, once the salt content of the temporarily fish farms is washed up, these farms should turn into agriculture.
Dealing with the limitation of natural resources (water & land)

Adopting any of the following scenarios:

Intensification of farming practices when economically feasible.

Promoting integration and/or rotation systems.

Introducing new initiatives such as aquaponics.

Focus on means for the utilization of under-utilized water resources especially marine or brackish water.

Piloting off-shore cages before encouraging private investments
Water scarcity and aquaculture: Intensification

Intensification trend is widely adopted under the limitation of land/water
Water scarcity and aquaculture: Integration with rice and other crops

Rice-fish culture

A large-size national program supported by the government with a total production of about 15,000 tons of common carp

Common carp fingerlings are provided at no cost

Integration with agriculture

The integration with horticulture is in practice (banana, guava, mango)

Also with vegetables & alfalfa

Reduced chemical fertilization & enhance product quality
Water scarcity and aquaculture: Rotation with strategic crops (wheat & alfalfa)

The rotation between aquaculture and wheat and alfalfa leads to a better use of land (win-win situation)

The practice began shy in the early 2000s

Still relatively insecure according to the Law 124

Change in legislations is required to promote this practice further

The outcomes of the conducted studies are positive

Quantifying the size of this practice is still based on field observations
Water scarcity and aquaculture: Use of under-utilized brackish water

Brackish under-ground sources are not adequately utilized –if any-

A promising water source subject to:
  Sustainability of water resources:
    Seems abundant (solid information)
  Availability of key infrastructure (especially roads and power)

Soil structure in the location

Longer lease term with reasonable fees
Aquaponics

Starts at experimental level
Expanding in expensive models at a slow rate
Great chance for dissemination
Greater potential whenever water gets scarce
Aquaponics for family consumption & rural development is expected

Example of tested crops
Screening will be based on production economics
Off-shore cages
Piloting before scaling-up

Egyptian-Italian project
European sea-bass and gilthead are the target species
Piloting takes place in the Mediterranean
Other water bodies such as Red Sea are targeted
Farm economics – High cost of feed

Most feed ingredients are imported and so influenced by the foreign exchange.

Over a 9-year period:
Feed prices increased by 284% while fish prices increased by 152%.
How could farmers survived the high feed cost?

• Accepting lower profits compared to before
• Increase the productivity/unit area (conditioned to economics)
• Enhance the utilization of feed
  – Better feed quality/better water stability
  – Reduce feed wastes (quality, feeders)
  – Reliance of natural food for sufficient time before administering commercial feed
  – Attempting to introduce non-feed consuming species such as silver carp (did not work as hoped)
  – Improving tilapia marketing and revenue (live fish marketing)
• Not much to do except waiting for the best which could be a function of others (price increase of red meat; bird flu)
• Attempting to use non-conventional ingredients was not practical due to wrong choices
A growing interest in the farming of some native species (e.g. African catfish and Nile perch).

The availability of Nile perch seed and the low marketability of African catfish represent a major constrain.

Expanding production basket could be partially addressed through processing and added value products.
Production basket: Promoting marine aquaculture (1)

The production of marine species is far below potential. The competition among various sectors (e.g. tourism) represents a main obstacle hindering the development of marine aquaculture.

Most marine fish could be marked locally especially some importation takes place (e.g. shrimp).

Export should consider the international competition.

Marine aquaculture along the new Suez Canal is hoped to significantly add to this sector
Production basket: Promoting marine aquaculture (2)

Existing facilities are sufficient to start with especially hatcheries and feed mills.

Adequately trained human resources are available.

Land-based farms on brackish & marine water is a promising once technically and economically justified.

Off-shore cages is getting more attention in the present and is now in the piloting phase.
Farming of European eels is practiced in several farms in one region.

Eel farming is stimulated by:
- availability of elvers
- market demand – high market price

However, the current practices are far below commercial level.
Training is a regular component in governmental programs (in-country and overseas)

Private training programs have been organized for different stakeholder categories (farmers, officials, processors)

Training curriculums tried to cope with development mode and challenges of the sector

Training the trainers was found very effective (governmental & academic staff)
Multi Sector Support Programme (MSSP), (1996-2004) was initiated by the Ministry of Agriculture and was funded by the European Commission (EC).

The program was designed to provide soft loans to four agricultural sectors including aquaculture.

Technical assistance was an integral component of the program to ensure successful implementation of credits.

Upon the completion of MSSP, the program has undergone some modifications and merging resulting in ASDP, ARDF and finally ADP program. However, providing soft developmental loans continue to be the key activity of the emerging programs.

Soft loans are also provided by the Social Fund for Development (SFD)
Laws, decrees and regulations to address:

Water and land use

Nile water is only permitted to freshwater hatcheries (not fish farms)

Fish farms are not permitted on agricultural land

There are current to revisit and change the articles on water/land use in aquaculture

Law of Environment (discharge of effluents)

According to the Environmental Law no. 4/1994, new aquaculture establishments have to comply with environmental standards (EIA has to be filed and accepted)
Laws, decrees and regulations to address:

Introduction of non-native species
   For several decades, no exotic species was allowed
   A scientific committee has to decide that

Use of veterinary drugs and chemicals
   Some chemicals are banned (e.g. sex reversal hormone and antibiotics)
   The use of a chemical in the origin country is a must

Feed manufacturing and additives
   Imported feed ingredients/additives should be approved
   Different formulas should be registered before manufacturing and use
Several species were introduced for aquaculture and are well established:
- Common carp
- Silver carp
- Grass carp
- Bighead carp

For biological control
- Mosquito fish for malaria control
- Black carp for bilharzia (research)

For aquaculture
- Freshwater prawn (experienced marketing difficulty)

Wrong aquaculture choice
- Red swamp crayfish
While 63.2% of African aquaculture is produced in Egypt, only 4.5% of caught fish in Africa is the share of Egypt.
Aquaculture & fishery (Egypt : World) 2013

Aquaculture (Egypt : World)  

Fishery (Egypt : World)

While 1.58% of World aquaculture is produced in Egypt, only 0.38% of caught fish in the world is the share of Egypt.
Institutional framework

**Key GAFRD Mandates**

- Implementation of national policy of fishery sector
- Enforcing fishery regulations
- Licensing aquaculture projects
- Establishing pilot projects
- Supporting national aquaculture projects
- International & regional cooperation
- Fishery statistics year book
- Extension service

Direct cooperation with:
- Aquatic police (Ministry of Interior)
- Ministry of Water Resources & Irrigation
- Aquatic Union (Cooperatives)

Cooperates with:
- Ministry of Environment
- Ministry of Public Health
- Universities & research institutes
- State Governorates
- Others
Aquaculture Research Network

Research institutes are affiliated to different governmental bodies:

**Ministry of Higher Education:**
- Universities – Departments in related colleges (agriculture, science, veterinary medicine) - two faculties of fisheries (Suez & Kafr El Sheikh)
- Academy of Scientific Research & Technology
- National institute of Oceanography and Fisheries
- National Research Center

**Ministry of Agriculture and Land Reclamation**
- Agricultural Research Center
- Central Laboratory for Aquaculture Research
- Lake Nasser Development Center

**International Organization**
- World Fish Center
Targeted fish production of 1.5 million tons from all resources by 2017 is achievable (probably earlier)

No matter how species diversification is required, tilapia will continue to be the leading species

Production economics will remain a key element in the sustainability of aquaculture development

As competition gets stronger, quality of fish products would be be highly considered

Issues such as disease, environmental concerns and product quality are expected to influence the development mode of aquaculture
Various types of integration are expected to spread out.

About a million tons of commercial fish feed will be needed by 2017; out of which a part should target marine fish and shrimp.

Local market will remain the focus of fish production with some specific exports whenever relative advantage exists (e.g. chilled tilapia fillets).

Practicing the farming of bivalve and oyster is expected to launch even for export.

Research should be working closely with production systems.

Extension service needs more support and should be engaged with producers, researchers and carried out by well-trained staff.