Planning of Aquaculture Projects
(Aquaculture systems – site evaluation – management – production inputs – production economics)

Abdel Rahman El Gamal, PhD
This presentation aims to:

Demonstrate the role of planning in the success or failure of aquaculture projects

Highlight the technical features of aquaculture projects

Emphasize on the technical and economic dimensions of aquaculture projects

Relate the available natural resources (land and water) to chosen farming practices

Establish a common understanding in relation to aquaculture practices and key descriptive

& to

Provide introductory materials for group projects
Aquaculture systems (productivity-based definitions) - kg/ha

**Absolute versus Relative**

In systems where various production levels could be obtained, no sharp line could be drawn for sorting farming systems indefinitely.

Relative approach shows that during 2000s, a production of 2000 kg/ha is defined “extensive” while 1500 kg/ha during 1980s was considered “semi-intensive”.

Systems planned for intensive farming are always defined “intensive”.

Relative classification could be based on spatial dimension and could vary from country to country and from one region to another.
Aquaculture systems – water quality-based definition (e.g. salinity)

Classic defining water in regard to salinity:

- **Fresh**: 0 - < 1 g/l (in agriculture)
- **Brackish**: < 1 – 33 g/l (unrealistic range)
- **Marine**: 33 g/l and above

Defining fish species according to salinity systems may lead to some confusions.

**Examples:**

- When seeds are produced in marine hatcheries but grown in different salinities including freshwater (e.g. mullet/shrimp/European seabass)
- When seeds are produced in freshwater and grown in saline waters (e.g. tilapia)

In order to eliminate any confusion related to salinity especially in brackish water:

Tell actual reading

Do definitions apply to hatcheries or farms?
Aquaculture systems - management based definition

Nutrition
- Special feed
- Complete feed
- Supplemental feed
- Fertilization

Water renewal
- Seepage & evaporation
- + Partial renewal
- High water renewal per day/hour
- Minimum renewal (closed system)

Aeration
- No aeration
- Emergency aeration
- Routine aeration
- More advanced systems (Liquid oxygen)
## Clarification of management systems

<table>
<thead>
<tr>
<th>Criteria - clarification</th>
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<tbody>
<tr>
<td><strong>Nutrition</strong></td>
<td>Fertilization is applied in less intensive systems of low water renewal. Higher quality feed indicates intensified approach. Special feed includes feed formulated to be used in environmentally sensitive areas (e.g. cage aquaculture).</td>
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<tr>
<td><strong>Water renewal</strong></td>
<td>Compensation for seepage and evaporation is done to maintain water volume over the growing season; usually in less intensive system. The increase in water renewal helps to clean the system from wastes and ammonia in higher intensive system. Closed-recirculated system has lowest water exchange while ranks high in the intensification level.</td>
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<td><strong>Aeration</strong></td>
<td>Aeration intensity and mode indicates the management of production unit:. Emergency aeration is applied to save farmed fish once oxygen drops to specific level. Routine aeration is included in the project planning of intensive systems.</td>
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<tr>
<td>Category</td>
<td>Description</td>
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<tr>
<td>Project finance</td>
<td>Personal or through limited arrangements</td>
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<td>Project products</td>
<td>Locally oriented</td>
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<tr>
<td>Technical assistance</td>
<td>Public extension is important</td>
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<td>Capacity building</td>
<td>On-farm basic training</td>
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<td>Partnerships with organizations &amp; centers</td>
<td>Often overlooked</td>
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More on aeration

When oxygen drops, aeration is more effective than water supply.

In emergency aeration in earthen ponds, aerating 1/3 of the pond will be sufficient.

Aerators circulates/mixes the water top to bottom (important for bottom animals).

Moves aerated water from the area close to the aerator and drags un-aerated water.

Allows harmful gases such as carbon dioxide to escape to the atmosphere.

**Turning-on aerators:** should be done ahead of fish surfacing.
Aeration systems (examples)

Pumps are for filling but not for aeration

Aeration in such system indicates intensity

Indicates routine aeration
Planning of Aquaculture Projects

Objectives of the Project

Specific: ton/ha kg/m³ Number & size of fingerlings

Never as much as possible or we will do our best

Realistic: with some challenge

Unrealistic (non attainable goals) = discouraging
Too easy goals = relaxing & damaging

Resources to achieve the goals

Human resources is a key resource; select, train and treat them fairly
Adequate production inputs
Natural & environmental resources: Soil – water – climate – etc.
Aquaculture Planning

Natural resources and Site Selection

Appropriate versus Optimum sites

Optimum may never exist. Thus, We go for the appropriate that should be carefully evaluated.

Inadequate sites was behind the failure of many projects.

Failure stories spread fast
Discouraging future developments
We need to ask: How important the soil is to the selection process?

Soil is most important in earthen ponds while has less important in tank farms while could be totally ignored in soilless systems (e.g. cages – aquaponic).

Clay soil conserves water while sandy soil leaks water.

Soil may be amended if this practice is economically justified.

For fish ponds, about **20-30% clay** is the minimum; also sand should not exceed 30%.

Soil laboratories are not only specialized in soil analysis but also provide recommendation in regard to the validity of soil amendments.
Soil amendments/lining

**Bentonite:** (clay type product): Bentonite has the ability to absorb water and expand in size and hence can fill the pores between coarse soil particles. Imported bentonite should be thoroughly mixed into the top 10-15 cm at a rate of 5–15 kg/m². (soil analysis will determine quantity needed)

**Clay blanket:** 30 cm thick to spread on pond bottom

**Water proof lining:** factors to consider:
Durability & cost - environmental effects (e.g. temperature)
Water requirements: should be compared very early in the planning process. In temperate regions: 30,000 - 40,000 m³/ha will be required (in earthen ponds) for filling and compensating for seepage and evaporation. Water renewal should be added to the above water budget.

If pumping is used, pump capacity should consider the peak of demand. The average is not sufficient.

In general: a pond is preferred to be fillable in about 3 days and should be drainable in 24-48 hours.
In intensive systems whereas water renewal is highly required, continuous supply should be considered.
In fresh water fish farms, and in low-input system, water renewal could be kept to minimum (just to make-up for water loss due to seepage and evaporation); salinity is not an issue.

In brackish/marine farms, water renewal with the right rate is a must to avoid salt accumulation – due to evaporation – during the growing season.

Thus, water renewal would vary in different climates.
Quality and species
Fish for water or water for fish (example: salinity)
Tolerance versus optimum (example: D.O and African catfish)

Quality and water sources
Surface: (e.g. pollution)
Under-ground: sustainability, limitations (heavy metals, dissolved gases)

Quality and aquaculture types
Farm – hatchery – cage - ....etc
Gas super-saturation

The saturation of nitrogen of more than 110% is considered problematic. If de-gassing is not possible in cases of high super saturation, it is better to re-evaluate the proposed project.

Heavy metals

Case study: This gravel filter for surface water has been a practical solution of the high iron content in the underground water.

If water quality is found very much inappropriate to the proposed project: Simply Drop IT.
Influencing factors & project planning

Influencing factors vary according to the nature of the projects and could be natural resources, climate, social elements, human resources, … etc.

Some of these factors could be handled easier than others (e.g. training)

Other factors are beyond the ability of planners to handle or cannot be economically justified (e.g. water quality, climate)

The recommended technology should be economically feasible

It is not wise to continue correcting for mistakes resulting from improper project planning instead of enhancing productivity

Tilapia hatchery in Japan

Under such freezing, tilapia spawning could be technically done for research; but commercial production seems difficult to justify economically
Project Planning – issues to consider

Plans have to consider all production aspects (technical, economical, social, .. etc)

Example: plans of a fish farm should include:

Source of fingerlings
- Outside sources (hatchery): timing & reliability
- In-house hatchery: rationality, capacity, extras
  All-males? All-females?

Special infrastructures: over-wintering facilities, .... etc.

Outputs (specific biomass/numbers, social benefits, etc.)

Economics (standard analysis)
Fish applies to finfish – crustacean – ornamentals - others

One species (monoculture) or polyculture? In regard to:

- Management such as feed requirement
- Environmental issues (e.g. DO, temperature)
- Length of the growing season and limiting species (e.g. tilapia in cold weather)
- System economics determines the feasibility of fish combinations in a polyculture system (e.g. carps in Egypt)

The cost of shrimp feed is much higher than that for their partner (mullet) in polyculture system
Utilization of farmed species

Should be determined early in the planning process indicating the utilization of the farmed species whether:

- marketed in local market
- processed
- exported
- Grown in other facility or
- Released in stock enhancement programs

Example: Seaweed culture

- Human food
- Agar-agar
- Soap making
Gravity in filling and draining of a fish pond is an ideal situation.

Land survey is essential for determining water flow system (filling/draining).

If only one operation is chosen for gravity, it should be draining.

If pumping is used for both operations, project economics should be analyzed.
Earthen ponds – filling & draining systems

Bottom draining removes harmful substances (ammonia, wastes)

Drying pond bottom saves most of preparation treatments

Filling
Pumping Capacity - maintenance

Axial Flow Pump

Selecting proper pumps considers its efficiency, operation and economics

Get technical opinion

Centrifuge Pump

Traditional water wheel

Pumping discharge is influenced by:
Pump horse power
Head
Project Planning
(sustainability concerns)

Wells may turn dry/salty – Need to consult water authorities

Environmental

Great start – random expansion
Banning – Reviving attempts
Culture Units
Factors to Consider – earthen ponds

Size of culture units:

Equal versus Different sizes
Different sizes → More flexibility

Large versus small ponds
Large ponds → More productive area at lower cost/unit of area
Small ponds → Better for fry nursing, broodfish maintenance

Easier to manage

BUT productive area is reduced at higher cost/unit

Planning for much smaller ponds should not be targeted as long as larger ones are quite manageable.

Defining large/small pond is a relative & changeable issue

For management purposes:
It is preferred to have equal size ponds with few ponds of different sizes
Relation of water depth in relation to temperature, salinity and acid rains

Pond depth although still within a range, optimum one is still debatable. (for grow out)

Deeper ponds are preferred in very hot climates and/or high salinity (ratio between surface and volume), and a must for over-wintering

Shallow waters lack enough buffering capacity
Filtration in relation to farming systems

UV sterilizer in oyster hatchery - Morocco

Tilapia project - Egypt

Freshwater prawn hatchery - Thailand

Gravel filter - Egypt

Babylon hatchery – Thailand Credit: Proyrat and Ong

In fish-horticulture - Egypt

Filtration should meet the requirements of the system and the organisms

No need to over-equip
Soil utilization: respect its nature

How many years will be required for leaching such salt crust?

Aquaculture – using marine fish species- is the wise approach for utilizing such land

Once salt is leached production economics determine the future of these lands (agriculture or aquaculture)
Farming Systems
(other than earthen ponds)

Farming systems in relationship to:
Water availability
  Scarce: (intensive, integration)
  Abundant: (raceways)

Environmental factors
(temperatures and closed systems)

Location
Desert: integration

Integration: compatibility

Investments: not necessarily high
Greenhouse construction and insulation capacity will depend upon climatic conditions and types of target activities.

- **For small-scale aquaponic (Colombia)**
- **For over-wintering tilapia (Egypt)**
- **For grow-out of whiteleg shrimp (Peru)**

*Credit: Edwin Ramirez (Colombia)*

*Credit: Victor Hugo (Peru)*
Integration concept

If properly done:
Better use of resources (water & land)
Benefits at levels:
  food
  environment
  economy

If done wrong: could lead to a disaster
(e.g. golden apple snail in rice fields in Asia)

More on integration is found in a special lecture on small-scale aquaculture
In order to conserve water, a 90-day rice strains were developed.

If the grow out of fish would require more than 90 days – leading crop would not wait and fish has to adopt.

More on integration is found in a special lecture on small-scale aquaculture.
Integration & economics

Economics determines the feasibility of proposed integration

The following items are considered:

Additional labor, cost and/or facilities required for the integration

Evaluating the integrating components versus the whole project (e.g. how to value the water discharged from a fish tank to the agricultural crops?)

The idea of Integrated tilapia with olives was not welcomed by olive producers who found that the revenue of such integration is not justifiable compared to their expensive olive oil

Thinking of organic olive oil led to reviving the rejected idea
Rotation (win-win situation)

Rotating crops should consider crop seasonality

Wheat and alfalfa are just examples which could rotate with tilapia

This example could justify a revisiting to land use policy
Small-scale Aquaculture

Has social goals (nutrition, employment, reduce migration)

Family can contribute to especially women

Main criteria is the ability to carry out the project with fair returns; food fish, fry, ornamental fish, ... etc.

Utilize what is available and safe of farm wastes and byproducts

Integration is mostly applied

Back-yard hatchery in Thailand is a success story

There is a special lecture on small-scale aquaculture
Influence of media & local names on marketing (e.g. freshwater prawn)

Unrealistic market estimates (e.g. seabass and seabream)

Reputation and unfair views (e.g. African catfish in Egypt); educate consumers first

Community consideration: Improving the project image among local community led to the stocking of some tilapia galilaea in Nile tilapia ponds (to produce smaller size tilapia as required by local consumers)

Produced size: depending on household income and feeding habits, premium size fish may not attain highest prices unless needed for further processing (e.g. filleting)
A Need to remember

Hatchery is not a farm

Evaluation of a hatchery will be seen on the farm (later)

Hatchery is the place for genetic enhancement

What could be tolerated by a farm may not be accepted to hatcheries (e.g. fluctuated temperature or salinity)

Information here is for the purpose of planning; there is a special lecture on hatchery management
Efficiency of a system (example: tilapia hatchery)

Efficiency depends on:
- Goals of the hatchery
- Available investments
- Technology in practice

Credit: Mohammad Iqbal (Pakistan)
**Compensatory growth**: an acceleration of the growth rate following a period of growth retardation caused by husbandry practices such as high stocking density which may lead to increased competition over food or space.
Production inputs
(feed)

Availability (quantity, quality)
Commercially or on-farm produced
Feed (Sinking/floating) in relation:
  management and labor
  feeding habits (shrimp as bottom feeder)
  Wind - Birds
Unconventional feed (relative)

Credit: Khamis Killei (South Sudan)
Production inputs
(fertilizers)

Fertilizers (organic/chemical)

Relationship with:
- Water management & renewal
- Farmed species and food habits
- Intensification level
- Possible health hazards? (e.g. organic manure & Bird flu)
- Residues (chemicals and drugs)
- Availability and comparable cost
Issues to consider
Fishery regulations & practices

Hatcheries have difficulty to compete with wild fry especially when:
  abundant
  at affordable price
Whether the collection of wild fry is regulated or illegal, the impact is the same
For a hatchery to operate, wait and hope for a poor wild fry season is not a wise approach

A hatchery success should not depend on the failure of the nature
### Issues to consider

#### Governing regulations

<table>
<thead>
<tr>
<th>Environmental regulations</th>
<th>Land tenure – water use</th>
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<tbody>
<tr>
<td>A sustainable project has to comply with the law in force in regard to:</td>
<td>Mode of land use: (owned, leased, temporary)</td>
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<tr>
<td>Quality of effluent (vary according to the activity)</td>
<td>Land tenure and project development</td>
</tr>
<tr>
<td>Farmed species (whether allowed in the country/location)</td>
<td>Water use permission (surface water or underground water)</td>
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<tr>
<td>Biosecurity (e.g. escapees)</td>
<td>Insufficient or changing water quality could ruin the project (example: salt intrusion in underground water)</td>
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<tr>
<td>Others</td>
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Insufficient or changing water quality could ruin the project (example: salt intrusion in underground water)
Issues to consider
Avoid over-equip & over-staff

Over-equip would affect the project economics: (Initial investment – depreciation)
It is unwise to purchase costly equipment which has no use in the near or mid-term future
Does not include standby equipment
This does not apply to some infrastructure (roads, pipes, etc.)
Should be treated as case by case

Over-staffing adds pressure on the operation cost
Over-staffing occurs more in governmental projects compared to private ones
Developing job descriptions for all categories would help avoid over-staffing
Staff training would improve the efficiency and possible mobilization of staff
Fair and transparent treatment is a must
Issues to consider
Very abnormal prices

Temporarily abnormal high or low farm-gate price should not be treated as normal in the planning or the analysis of the project.

**Examples:**

Exceptional high prices of a given fish species in particular season of for unusual market event.

The very low price –if any- for crawfish in Egypt may not remain as such if a project for collecting and processing the species does exist.
## Project personnel (safety issues)

### Potential threats

- **Nature of aquaculture projects** needs to be considered including:
  - **Locations**: Often in harsh and remote areas
  - **Water-borne diseases**: for pond workers (e.g. Schistosomiasis)
  - **Direct exposure to chemicals**: (e.g. hormones in tilapia sex reversal)
  - **Greenhouse humidity**: for hatchery operators and workers

### Safety actions (examples)

- Limiting the matter to paying project workers extra incentives against harsh environment is unfair
- Enforcing the occupational safety should be done.
- Providing protective clothes (e.g. waders, gloves)
- Periodic medical checks is important
For a sustainable and feasible project, all elements need to be considered and fairly evaluated (Physical, environmental, human, etc.).

The planning process should be based on reliable information with no biased views.

Proper economic analysis is a must – its outcomes should be respected.

Business plan is not be rigid and should be periodically reviewed and adjusted if necessary.
Production economics

In order for a project to be sustainable, it has to be economically feasible.

Highest production versus economic production.

Marketable Size & best economical size.

Opportunities and possible risks should be considered in the economic analysis.

Key parameters:

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<th>IRR</th>
<th>NPV</th>
<th>Pay back period</th>
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## SWOT Analysis

<table>
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<th>Strengths</th>
<th>Weaknesses</th>
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<tr>
<td>Experienced and committed</td>
<td>Inadequate number of staff</td>
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<tr>
<td>management staff</td>
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<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
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<tbody>
<tr>
<td>Government policy supportive,</td>
<td>Regulation and compliance risks,</td>
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<tr>
<td>support to farmers through</td>
<td>Water pollution, Fish diseases,</td>
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<td>training and material inputs.</td>
<td>Cost inflation, Industry</td>
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<td>consolidation/transition,</td>
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<td>consumer demand shifts, global</td>
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<td>financial shocks, theft, floods,</td>
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<td>energy shocks, corruption, late</td>
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<td>timing for current donor funds.</td>
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**SWOT analysis** is a planning tool used to evaluate the **Strengths**, **Weaknesses**, **Opportunities**, and **Threats** related to a project.

Source: Training team, EICA. Hatchery establishment for African catfish fry production in Mukono district, Uganda
The success or failure of aquaculture project – like any project - is directly related to proper/improper planning

Technical/economical sides should be equally considered during planning

Projects of social benefits are usually supported by governments (e.g. mal-nutrition, employment, migration)

People are the most precious resources to be considered in the planning process

Proper planning ensures stable applications and avoids unpleasant surprises