Planning of Aquaculture Projects

(Aquaculture systems – site evaluation – management – production inputs – production economics)

Abdel Rahman El Gamal, PhD

www.fishconsult.org

October, 2014

Planning of aquaculture projects

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 descriptives

& to

Provide introductory materials for group projects

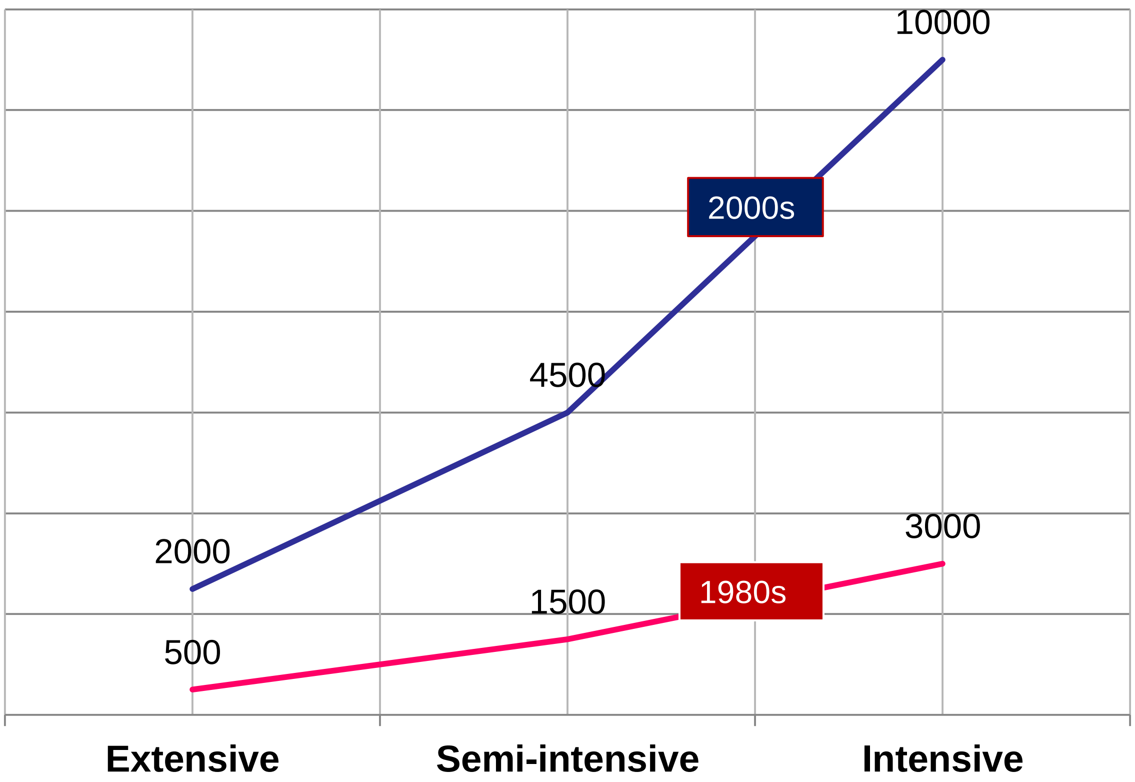
Aquaculture systems (productivity-based definitions) - kg/ha

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 ✓

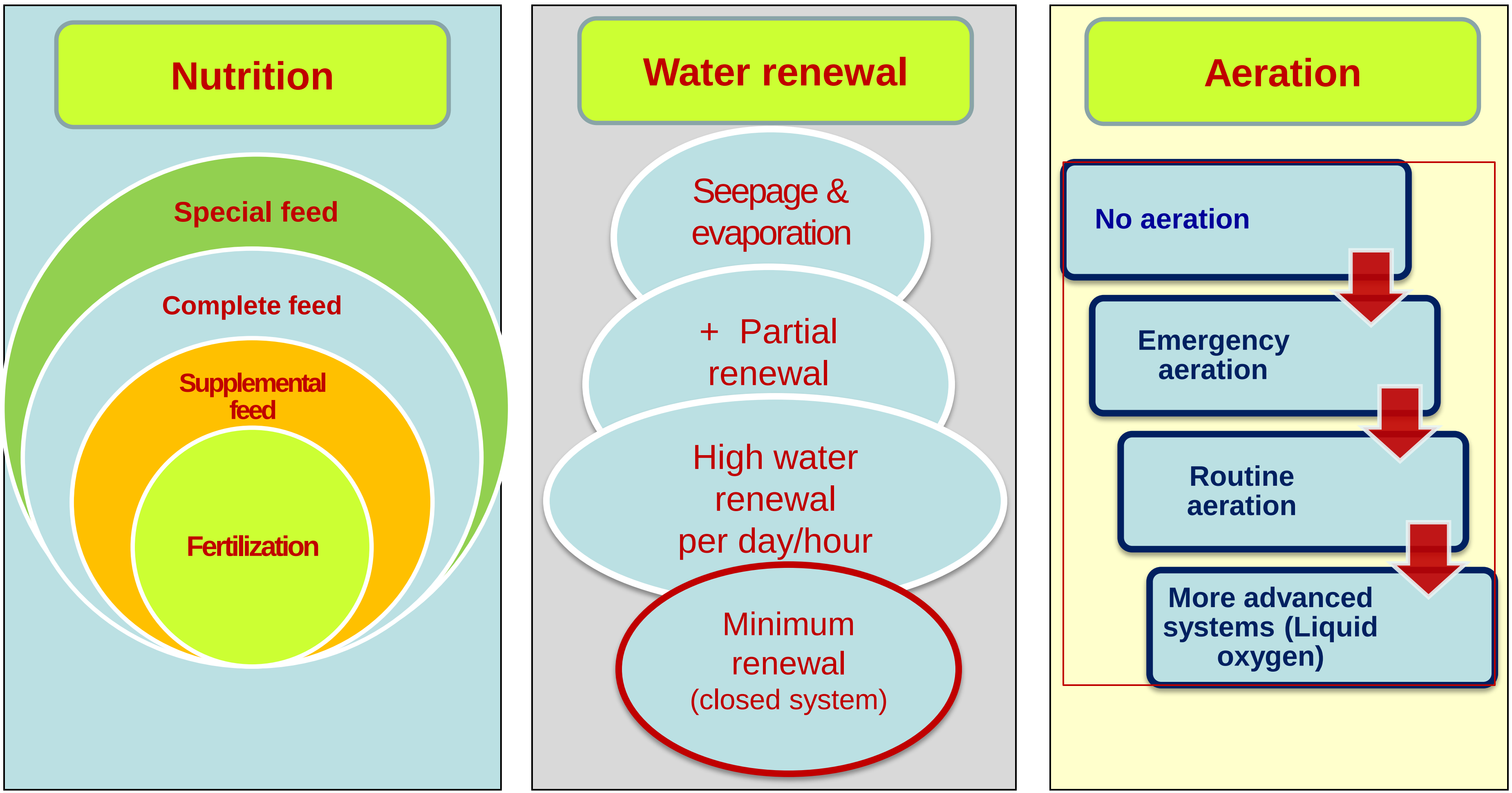
Defining fish species according to salinity systems may lead to some confusions.
Examples:
When seeds are produced in marine hatcheries but grown in different salinities including freshwater (e.g. mullet/shrimp/European seabass)
When seeds are produced in freshwater and grown in saline waters (e.g. tilapia)

Do definitions apply to hatcheries or farms?

It is very simple to eliminate and confusion related to salinity categories especially in debatable or wide ranges:

Tell the actual measure

Aquaculture systems - management based definition



Clarification of management systems

	Criteria - clarification
Nutrition	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)
Water renewal	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
Aeration	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

More on aeration

When oxygen drops, aeration is more effective than water supply

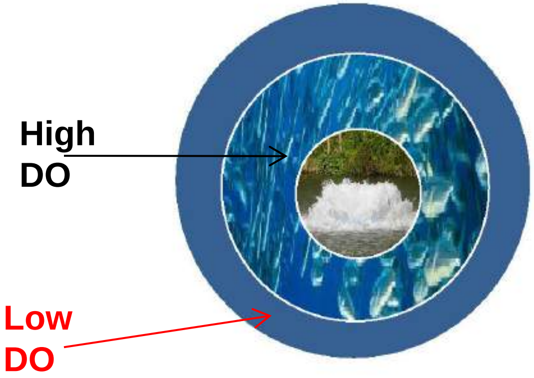
In emergency aeration in earthen ponds, aerating 1/3 of the pond will be sufficient

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/m^3 Number & size of fingerlings

Never as much as possible

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 usually Discourages future development

Project planning - Soil

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/m^2. (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)

Project planning – Water quantity

<u>Water requirements</u>: should be compared very early in the planning process. In temperate regions: 30,000 - 40,000 m^3 /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. **<u>The average is not sufficient</u>**.

<u>In general:</u> a pond is preferred to be fillable in about 3 days and should be drainable in 24-48 hours.

Water supply in intensive systems

In intensive systems whereas water renewal is highly required, continuous supply should be considered.

Project planning – Water quality

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

Water quality
(Examples)

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

If water quality is found very much inappropriate to the proposed project:

Simply Drop IT

Heavy metals

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

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)

Project Planning – Fish species

Fish applies to finfish – crustacean – ornamentals - others

One species (monoculture) or polyculture? 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
- Released in stock enhancement programs

Example:
Seaweed culture

Human food
Agar-agar

Soap making

Management of production units
Water filling & discharging in earthen ponds

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

Gravity filling

Gravity draining

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

Centrifuge Pump

Consult who knows

Traditional water wheel

Water discharge of a pump depends on:
- HP of the pump
- Head

Project Planning
(sustainability concerns)

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

Environmental

Great start – **random** expansion

Banned - Reviving

Culture Units
Factors to Consider

For management purposes:

Most farm ponds is preferred to be of equal size with few ponds of different size

Size of culture units:

Equal versus Different sizes

Different sizes → More flexibility

Large versus small ponds

Large ponds → More productive area at low cost

Small ponds → Better for nursing, broodfish

Easier to manage

BUT reduce productive area

Unless there are clear reasons, it is not recommended to plan for smaller ponds if larger ones are quite manageable

Depth of fish pond

Relation of water depth in relation to temperature, salinity and acid rains

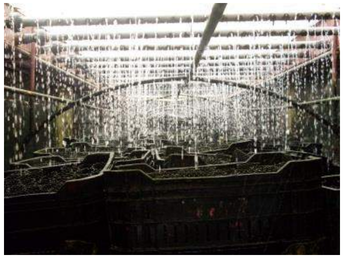
Pond depth although still within a range, optimum one is still debatable. (for grow out)

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

Greenhouses & purposes

Green house construction and insulation capacity will depend upon climatic conditions and types of targeted activities

For small-scale aquaponic (Colombia)

Credit: Edwin Ramirez (Colombia)

For over-wintering tilapia (Egypt)

For grow-out of whiteleg shrimp (Peru)

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)

Golden apple snail

More on integration is found in a special lecture on small-scale aquaculture

More on Integration

Leading crop

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

Compatibility

Warm blood animals swim over a cold blooded system

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

More on integration is found in a special lecture on small-scale aquaculture

Production & marketing (case studies)

Influence of media & local names on marketing (e.g. freshwater prawn)

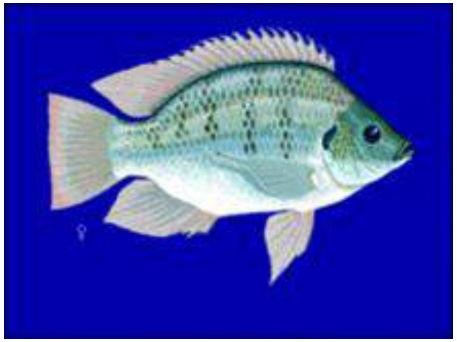
Unrealistic market estimates (e.g. seabass and seabream)

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

Community consideration: Improving the image of a project among the local community through stocking some tilapia galilaea in Nile tilapia ponds

Premium sizes & changing prices: depending on household income and feeding habits, premium size fish may not attain highest prices

Claws?



Project Planning
(Hatchery Project)

<u>A Need to remember</u>

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)

Efficiency of a system (example: tilapia hatchery)

Efficiency depends on:

Goals of the hatchery

Available investments

Technology in practice

Egg collection

Fry collection

Credit: Mohammad Iqbal (Pakistan)

Towards Natural Systems

Common Carp

Sticky eggs of common carp

Tilapia

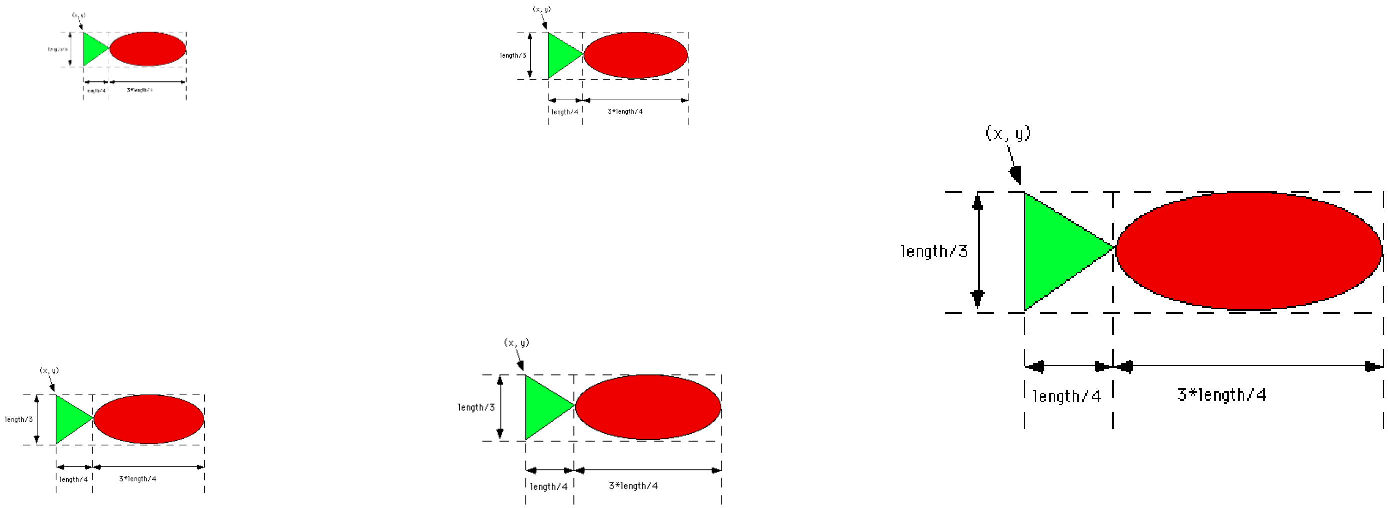
Nursing (the right of young)

Feeding ratios do not apply during early nursing

No matter where a larvae stays or moves, Its food should be there

Hatchery

Number versus size & compensatory gain



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

Enhancing Hatchery Efficiency
Multi-species Hatchery



Compatible species should have over-lapping spawning season

Species combinations could be spawned using the existing hatchery facilities

Additional or modification of existing facilities if needed, should be economically justified

The production of multi-size fingerlings is a valid approach for enhancing hatchery efficiency if found economically feasible



Enhancing Hatchery Efficiency

Extending spawning season

Extending the spawning season for several species through the manipulation of light and temperature

Greenhouses and heating enable tilapia to spawn during cold winter in order to distribute fry to farms as temperature in open farms turns safe

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)

Daily allowance (*ad libitum*? Less? More? How?)

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

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

IRR	NPV	Pay back period

SWOT Analysis

Strengths Experienced and committed management staff	**Weaknesses** Inadequate number of staff
Opportunities Government policy supportive, support to farmers through training and material inputs.	**Threats** Regulation and compliance risks, Water pollution, Fish diseases, Cost inflation, Industry consolidation/ transition, consumer demand shifts, global financial shocks, theft, floods, energy shocks, corruption, late timing for current donor funds.

SWOT analysis is a planning tool used to evaluate the **S**trengths, **W**eaknesses, **O**pportunities, and **T**hreats related to a project

Competition?

Source: Training team, EICA. Hatchery establishment for African catfish fry production in Mukono district, Uganda

Conclusion

Like any project, the success or failure of aquaculture 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

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

Proper planning ensures stable applications and avoids unpleasant surprises