Lectures presented in workshop on
'Developing integrated aquaculture – horticulture systems with brackish and salt water', held at
Al Solaimaneyah Hotel, Al Solaimaneyah City, Egypt
May 14, 2013

1. **Dr. Greet Blom,** Plant Research International, Wageningen UR
2. **Hubrecht & Maarten Janse,** De Heerlijkheid van Wolphaartsdijk
3. **Peter G.M. van der Heijden,** Centre for Development Innovation, Wageningen UR
4. **Dr. Sherif Sadek & Eng. Mohamed Sabry,** Aquaculture Consultant Office, **Eslam, Elsamadony,** Rula for Land Reclamation, & **Mahmoud Ewas,** RLR
5. **Eng. Prof. Hassan M. El Shaer,** Desert Research Center
6. **Marc Verkuyl,** Coppens International
7. **Faris Farrag & Ziad Abou El Nasr,** Bustan Aquaponics

wadi Food

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INTEGRATED AQUACULTURE AGRICULTURE SYSTEMS WITH BRACKISH AND SALT WATER

Organized by:

WADI GROUP

CDI and PRI

(both part of Wageningen University & Research Centre)

May 13 and 14, 2013

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Developing the culture of salt resistant crops (halophytes) at Rula for Land Reclamation

Greet Blom-Zandstra

May 13th, 2013

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Aim

Fish farm produces daily effluent

Growing halophytes for sustainable re-use

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Profitable crops in saline environments

Vegetables

- Salicornia (Samphire)
- Sarcocornia

Fodder

- Suaeda
- Atriplex
- Salsola
- Spergularia

Ornamentals

- Rosa
- Frankenia

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Profitable crops in saline environments

Energy crops (+ eventually shadow)

- Tamarix
- Acacia
- Lebbek
- Mangrove

Tamarix nilotica

Oil containing crops

- Moringa
- Jojoba

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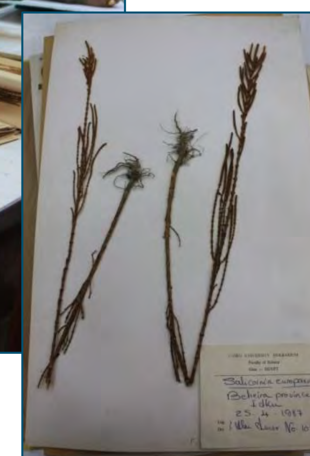
Crops suitable for Rula

Salicornia (seeds from The Netherlands)

- S. europaea
- S. procumbens

Visit to herbarium

- Native Egyptian species
- Differences between species
- Seasonal characteristics: ripening & setting seeds



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Differences between plant species

Sarcocornia *Salicornia*

both in edible stage

S. europaea *S. procumbens*

both after ripening

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Collecting seeds

Natural vegetation along the Alexandria desert road

Salicornia europaea

Atriplex halimus

Suaeda vermiculata

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Collecting seeds

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Growth in nursery with fresh water

Germination seeds

- Salicornia
- Atriplex
- Suaeda

Purchased seedlings

- Acacia, Moranga, Lebbek

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Results nursery phase

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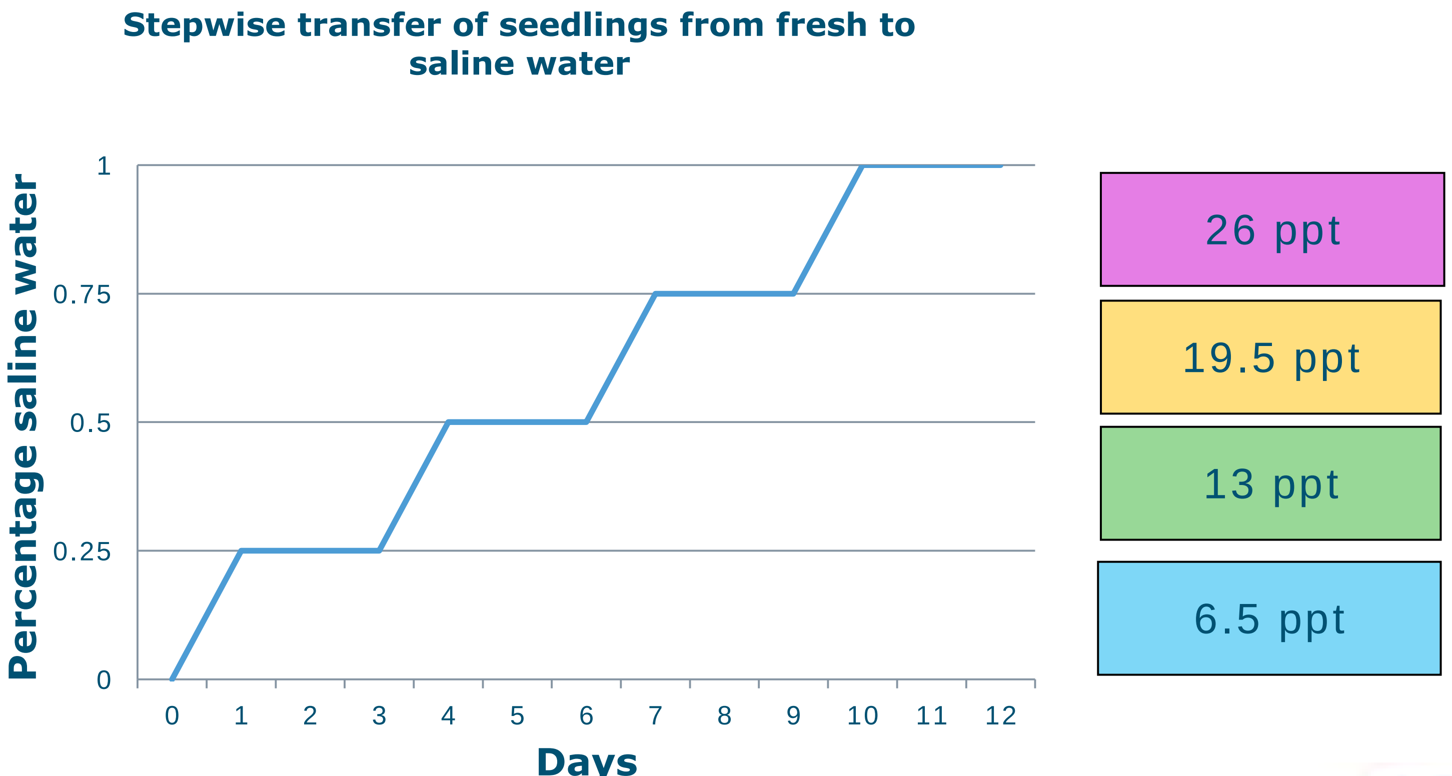
Preparing plants to field conditions

Stepwise adaptation to saline conditions



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Transplanting to the field

- Preparing the field
- Transfer of plants at *circa* 10 cm length

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Growth characteristics

August

Salicornia

Atriplex

Suaeda

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Growth characteristics

September

Salicornia

Atriplex

Suaeda

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Growth characteristics

November

Salicornia

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Growth characteristics

December

Salicornia

Atriplex

Suaeda

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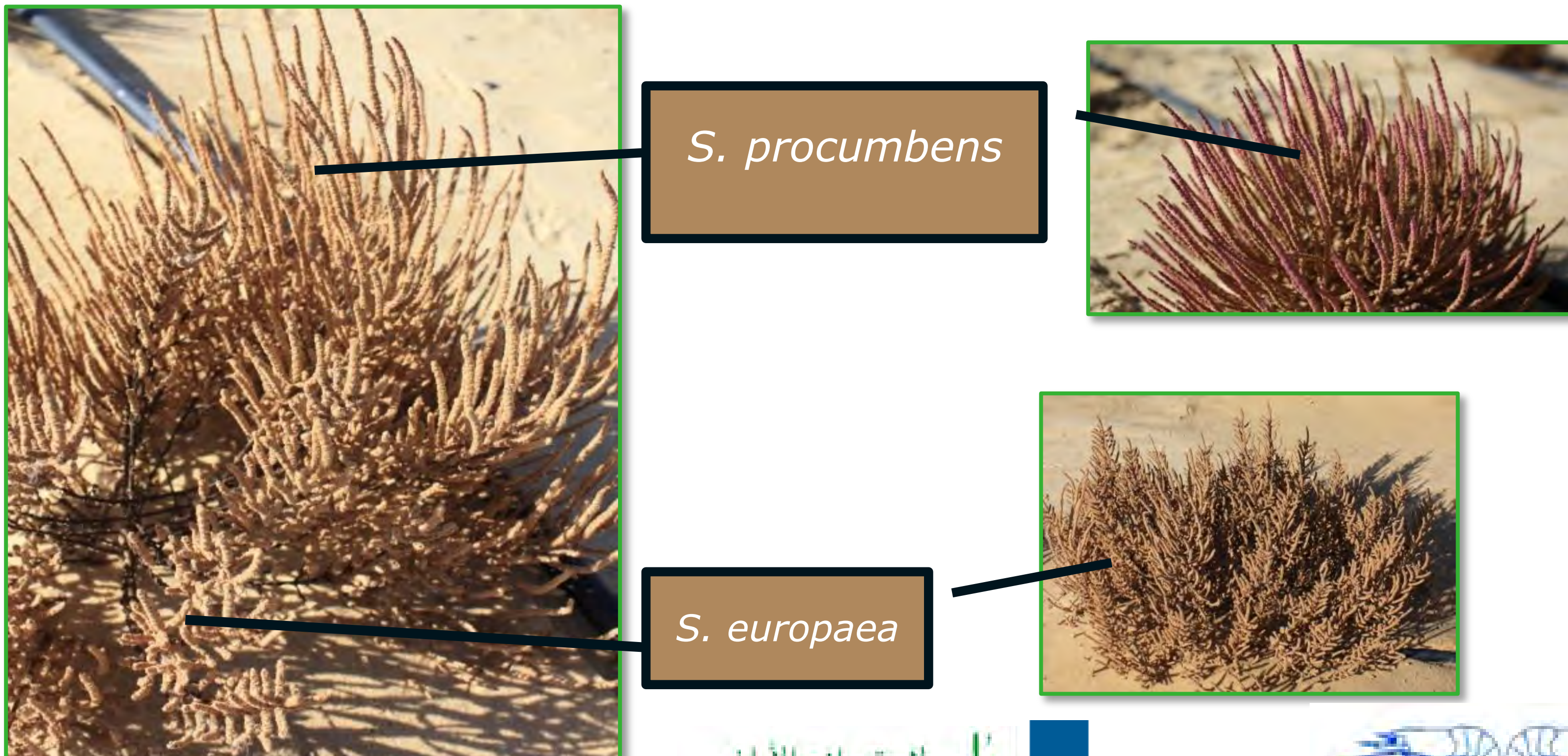
Growth characteristics

visible differences between
S. europaea and *S. procumbens*



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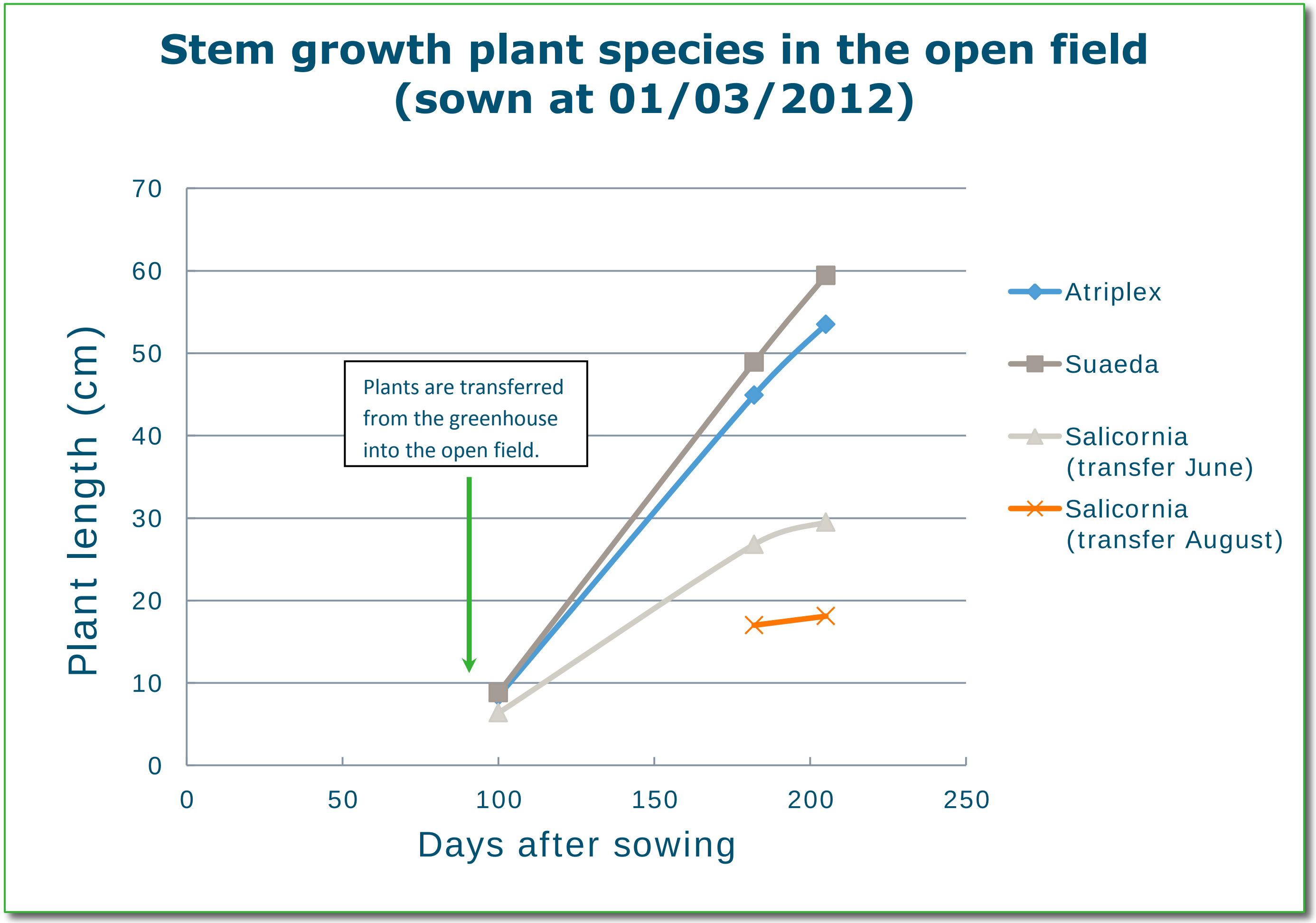
Growth measurements



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Conclusions

- Seeds need fresh water to germinate
- Small seedlings can be adapted to saline water stepwise. The sooner, the better the taste
- Transfer to the field as soon as possible for optimal growth
- Plant density depends on species: Salicornia grows dense; Atriplex and Suaeda need more space
- If possible, direct sowing in the field

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2013: Direct sowing in the field

- Protection against cold and wind
- Short period fresh water,
- Then saline water

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Recommendations for further testing

Sowing Salicornia

1. Chopped plant material direct to the field (Mexico)






2. Growing Salicornia within a greenhouse during all of the growing season (a.o. China)




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Thanks for your attention

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Experiences with *Salicornia* culture and sale in The Netherlands

Hubrecht & Maarten Janse

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The Netherlands

www.heerlijkheidwolphaartsdijk.nl
@zeeuwszilt @heerlijkheidvw

Zeeuws Zilt

de Heerlijkheid van Wolphaartsdijk®

Hubrecht Janse

Zeeuws Zilt

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Changes from 1959 until 2011

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Former salt marshes

1953: A terrible flood disaster happened

1795 people died

Sea inlet has been closed at two sides (‘Deltaplan’)

A lake (‘Veerse Meer’) was formed

Marshes became dry and were reclaimed

The ground could be used for agriculture from the sixties

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From Arable Farming to Broadening

Threats

- Limited possibilities to extend agricultural area
  - Not much land available and therefore expensive (€ 70.000,- per ha)
- Need for more profit
- Salinization lowest fields
  - Leaching of sea water into the lake
  - High water level lake during winter -> drainage insufficient
  - Saline seepage

Challenge

- Growing halophytes and recreation along the lake

Founding of 'De Heerlijkheid van Wolphaartsdijk'

Saline agriculture + arable farming + recreation

- Since 1969 on reclaimed grounds
- Dynamic and innovative company, run by the family
- Make optimal use of environmental conditions

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Selling points

- Customer friendliness
- Water rich environment
- Possibilities to relax
- Rural experience
- Enjoyment
- Delicious products

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Camping site

- Room for 75 tents or caravans
- Electricity, water and garbage containers
- Natural vegetation
- Swimming facilities
- Inviting starting point for tours by bike, by car or hiking
- Natural reserves in the surroundings

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Farming salt tolerant crops

- Salinity visible (picture)

- Direct supply of saline water (28 ppt) from lake
- Field level below water level of the lake
- Drainage tubes to ditches
- Pump for drainage next to fields

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Edible crops with delicious salty taste

- Salt tolerant crops
  - Salicornia
  - sea aster
- Salty taste due to salt water from lake
- Plant products characteristic for region, like:
  - Fresh salty vegetable
  - Cheese
  - Bread
  - Liquors
  - balsamico vinegar
  - skin creme

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Aquaculture

Production of worms:

- Fishing bait (hobby fishermen)
- Feed for commercial fish farming
  - Sole
  - shrimps

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Arable farming

Circa 60 ha (Global-GAP certified)

- Potatoes
- Sugar beets
- Wheat
- Grass seeds
- Environmental management (2 km)
  - Part 75 km hike network
  - Birds (like skylark)

Roof solar panels

- Self sufficient for 75%

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Salicornia

- Native in The Netherlands
- Growing worldwide
  - in saline environments
  - in estuaria
  - along coasts

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Culture of Salicornia

- On plots (1.25 x 30.0 m) adjacent to each other
- Mechanical ploughing, sowing and harvesting (GPS driven)
- Sowing directly in the field
- Sprinkler irrigation

- Attention needed
  - To prevent the growing of weeds
  - To keep the plots wet
  - To drain sufficiently during rainfall

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Clay versus sand

- More capillary percolation
- Coarser structure
- Stays longer wet
- Nutrients more available

But

- More salt accumulation

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Combining the growth of worms and Salicornia

Both are grown in the same pond in order to close the nutrient cycle

- Autumn and winter: Worms
- Spring and summer: Salicornia
  - Production of organic matter and nutrients (plant roots, feed remains, excrements of worms)

↓

  - Nutrients for plant growth

Salicornia grows under wet conditions

Saline soils dry out slower than non-saline soils

Salicornia in the edible phase

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Salicornia in the edible phase

Salicornia in the edible phase

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Product

- Has historical value in the region
  - > sale to locals
- Sale in rest of the Netherlands limited; high costs for logistics
- Many steps in the retail
- Many competitors from France in growing season (May – August)

Supply to the consumer

- Direct sale to consumer (no retail)
- Extend growing season
  - Improvement breed
  - Improvement management
  - Cooperation with other (foreign) growers
- Intensive PR
  - Info about origin
  - Recommendation as regional product
  - Certified
- Registered trademark

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Other products

- Skin care resources
- Canned food
- Mayonaise
- Mustard
- Liquor

Demand

- Tourism
- Summer markets
- Gifts

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Specialty

Typical for our region:

Cheese with Salicornia, sea aster and onion

Produced in cooperation with a local cheese farm

Salicornia grown for breeding

Vegetative phase

Ripe and ready for harvest

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Thanks for your attention

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Theory of biofloc systems for fish culture

Development of integrated aquaculture / horticulture systems with brackish and salt water in Egypt

Peter G.M. van der Heijden

May 13, 2013

Ministry of Economic Affairs

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Rula For Land Reclamation

Centre for Development Innovation

Development of integrated aquaculture / horticulture systems with brackish and salt water in Egypt 2011-2012

Project partners:

Rula for Land Reclamation (*Wadi Food)*

Aquaculture Consultant Office ACO

Wageningen UR (*Centre for Development Innovation and Plant Research International),*

Co-financed by Netherlands Ministry of Economic Affairs

Development of integrated aquaculture / horticulture systems with brackish and salt water in Egypt

Objectives: Study and test technical feasibility for integrated saline aquaculture – agriculture (fish & salt-resistant crops = halophytes)

Location: Rula for Land Reclamation olive plantation in Wadi El Natroun, Egypt

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History:

- This project is part of 8 years of history of Dutch support to the Egyptian aquaculture sector through support to the Egyptian Fish Council (under EGA) and to small projects (studies, tests) that are all related to the question how the Egyptian aquaculture sector can deal with fresh water scarcity.
- Projects are aimed at demonstration, investigation and testing of more water-efficient ways of producing fish (more kg fish produced per m^3 of water) by
  - Look into the integration of aquaculture with agriculture;
  - making the sector acquainted with Recirculation Systems (training courses on recirculation systems and study visits to farms with RAS in Holland, support to Recirculation System of Dr. Ismael Radwan).
- Projects were implemented in close cooperation with World Fish Centre, EGA and with private companies

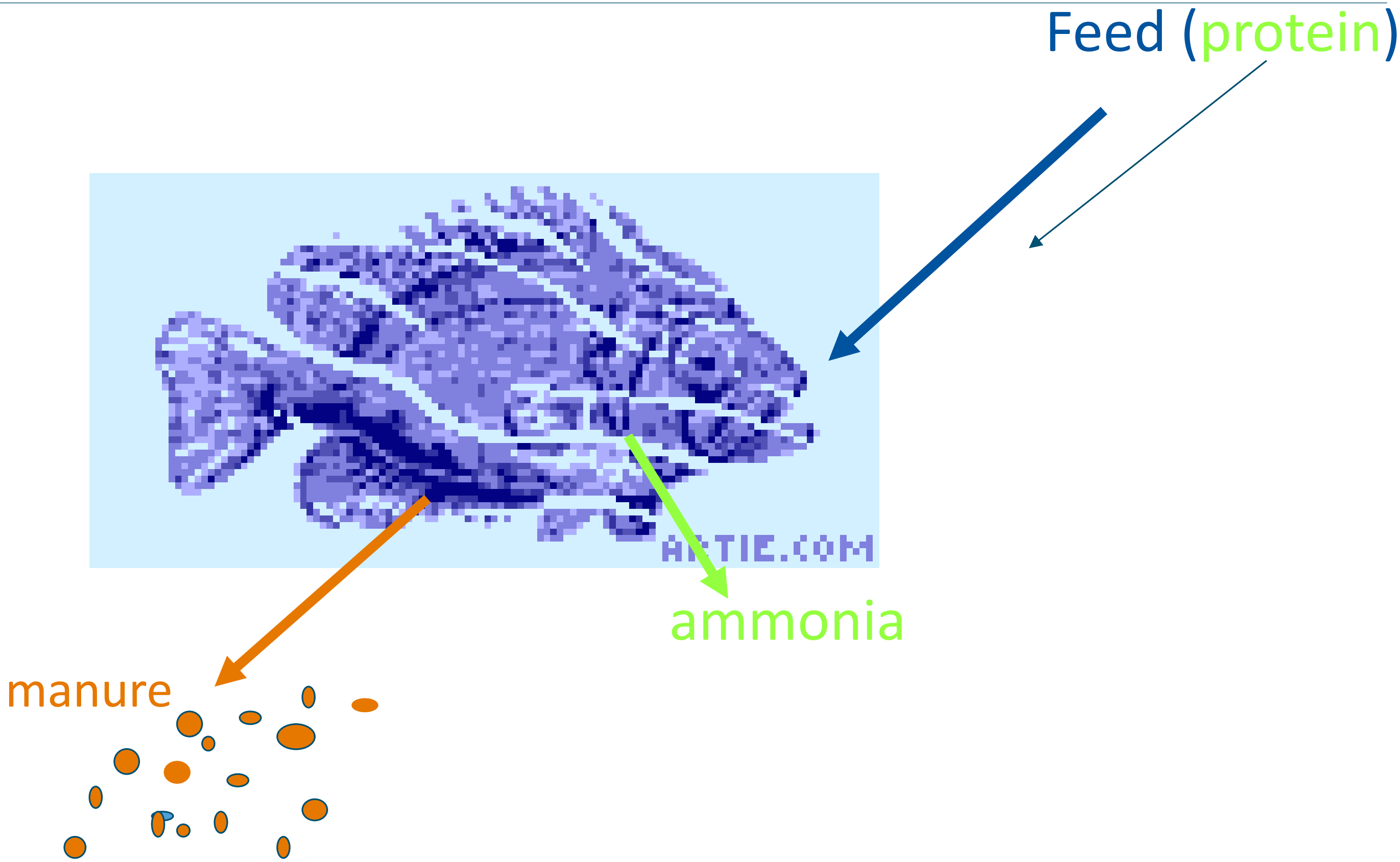
Development of integrated aquaculture / horticulture systems with brackish and salt water

- **Starting point:** saline effluent (26 gr/ltr) from Wadi Food Intensive Fish Farm (sea bass & sea bream). Can we make use of this waste water in a productive way? This fits with Gov't of Egypt objective to stimulate the use of saline & brackish water for agriculture and aquaculture.
    - Salt-tolerant crops (halophytes)
    - Can a second fish culture component be added based on the effluent, making use of the nutrients added by the fish farm? Can we combine this with testing another water-efficient method to grow fish? -> Biofloc technology

Biofloc technology: theoretical background

- Biofloc systems were first developed for shrimp culture (*Peneaus vanamei)*
- Dr. Yoram Avnimelech was one of the first to do research on this (from 1994 onwards), especially with tilapia
- One of the companies pioneering the concept for shrimp farming was Belize Aquaculture Ltd (production in 1999 of 205 ton shrimp from 15.2 ha ponds), and now more shrimps farms are using this technique.

Principle



Biofloc theory (1)

- On average only about 25 – 30 % of the protein in fish feed protein is converted to fish tissue (growth), the rest (65 - 70%) is excreeted (mostly as ammonia) as waste in the water.
- Too high ammonia levels cause stress to fish, suppress growth and limit fish farming yields
- Common solution to ammonia accumulation is
  - replacing part of the pond water (flushing) → water lost, nitrogen lost and possibly harming the fish farm environment (pollution, eutrofication).
  - Lower the pH of the water
  - Apply biological filters

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Biofloc theory (2)

- Normalyy, manure and feed particles settle on the bottom. When not enough oxygen is available they accummulate and rotting starts (harmful materials such as Hydrogen sulfide, methane and nitrite develop).
- When continuously mixed, the particles stay floating in the water column and stay in contact with oxygen
- Much of the carbon present in the feed is lost in the air due to CO_2 formation. For good bacteria growth the ratio of Carbon (C) to Nitrogen (N) in the water should be

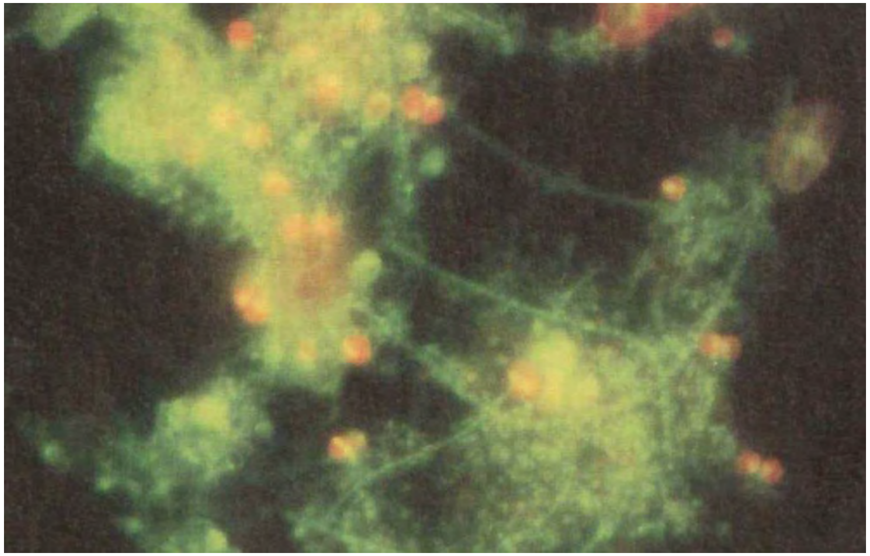
  C/N = 20 : 1. With this ratio all Nitrogen can be used to build bacteria protein. This ratio is obtained with feed with approx. 20% Crude Protein levels.
- If feed with higher crude protein levels are given, the C/N ratio is less and excess ammonia starts to form and accumulate in the water. In biofloc system this problem is treated with addition of extra carbohydrates such as molasses, starch, etc.

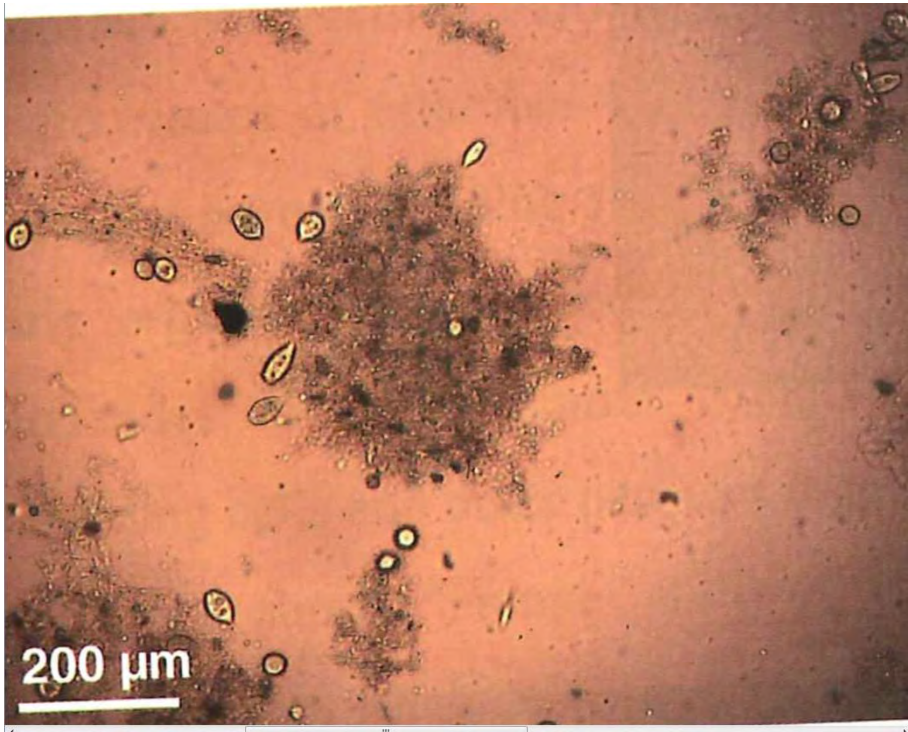
Biofloc theory (3)

- Biofloc systems are **intensive** aquaculture systems that have intense aeration and mixing with paddle wheels and very little or no water exchange.
- Intensive aeration is necessary to supply oxygen to fish (or shrimp) and bacteria
- Intensive mixing is necessary to prevent that the particles sink to the bottom. They should remain drifting in the water column (in suspension).
- The particles that are covered with bacteria absorb ammonia (purify the water), provided that enough carbohydrates is available: ammonia removal takes place in the pond or bassin!

Biofloc (4)

- Particles coated with bacteria produce slime that make them stick together and that catch algae → in this way flocs are formed. These flocs (mixture of bacteria and algae) are a protein-rich feed for tilapia.
- Photos of bioflocs (courtesy Dr Michele Burford)





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Biofloc after settlement in cone

(photo: Y. Avnimelech)

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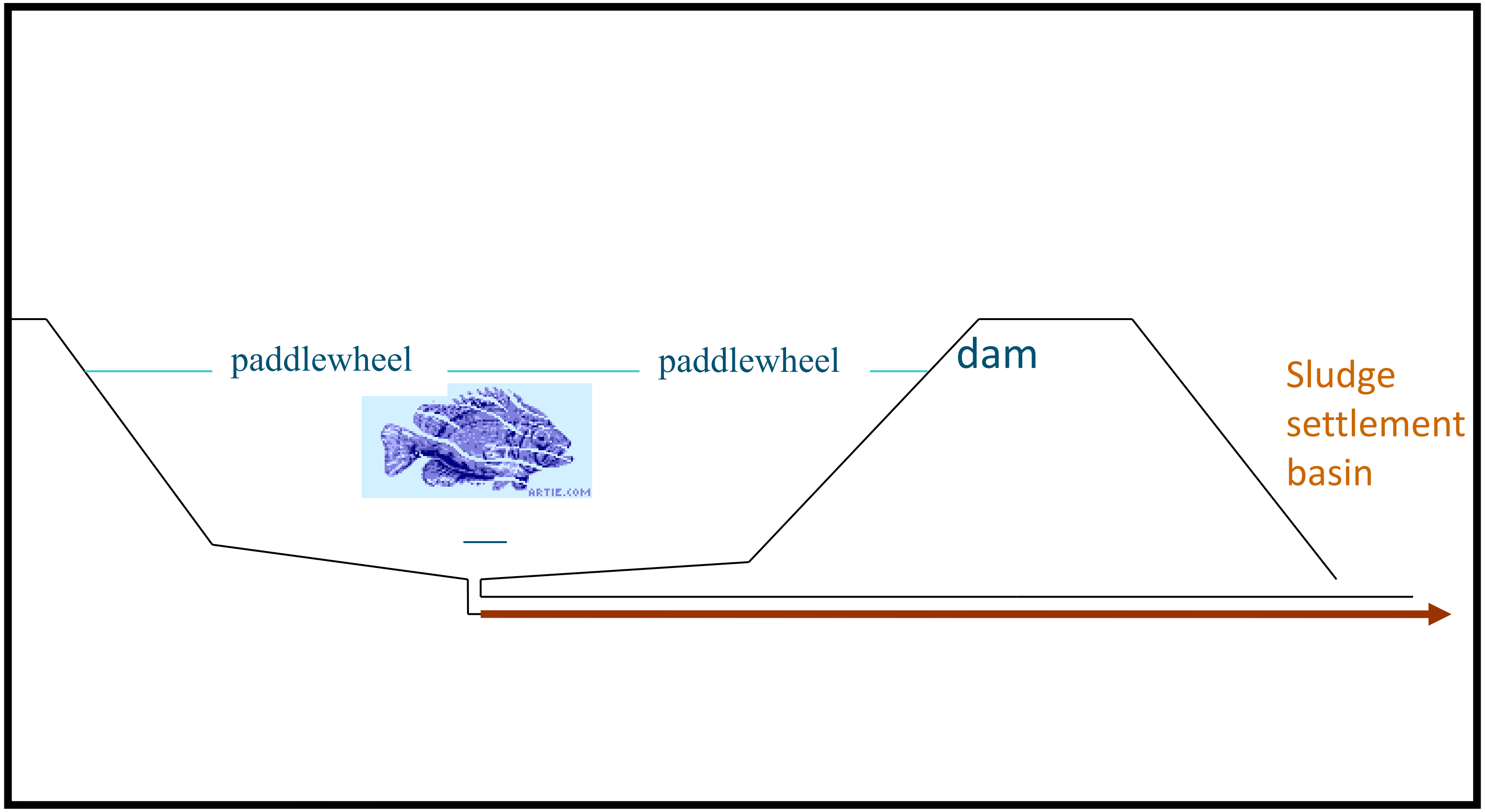
Sketch of pond with biofloc system (side view)

small ponds, concrete or plastic lined



Advantages of biofloc system

- Intensive fish culture is possible: 20 – 25 kg tilapia /m^2
- Water use is much reduced.
- Flocs are eaten, feed costs are reduced (with approx 30%)
- The protein in feed is used 2x more effectively.
- To maintain the Carbon : Nitrogen ratio at 20:1 a feed with lower protein level can be used
- Experiments comparing 30% protein feed with 20% protein feed gave higher yield, larger final weight and better survival rate for biofloc ponds fed with feed with 20% protein level.
- When feed with protein level > 20% is fed the farmer should add a source of carbohydrates (ground maize, ground wheat, starch, molasses). The amount depends on the CP level of the high protein feed (approx 58% in case feed with CP level of 30% is fed).

Disadvantages

- Rather high investment and energy costs (28 Hp/ha)
- Reliable electricity supply is essential: if more than one hour electricity failure → mass mortality of fish
- Smallponds of concrete or plastic lined are recommended: these are more easily to manage and can be covered in winter to raise temperature

- First trial with culture of red tilapia in biofloc system has promising results

Photos of harvest of red tilapia raised in biofloc tanks

(Photos: Peter van der Heijden)

First results with testing biofloc technique with red tilapia in saline fish farm effluent

Steps – Results – Conclusions

Dr. Sherif Sadek (Aquaculture Consultant Office), Eng. Eslam Elsamadony (Rula For Land Reclamation),Mr. Mahmoud Ewas (RLR) and Eng. Mohamed Sabry (ACO)

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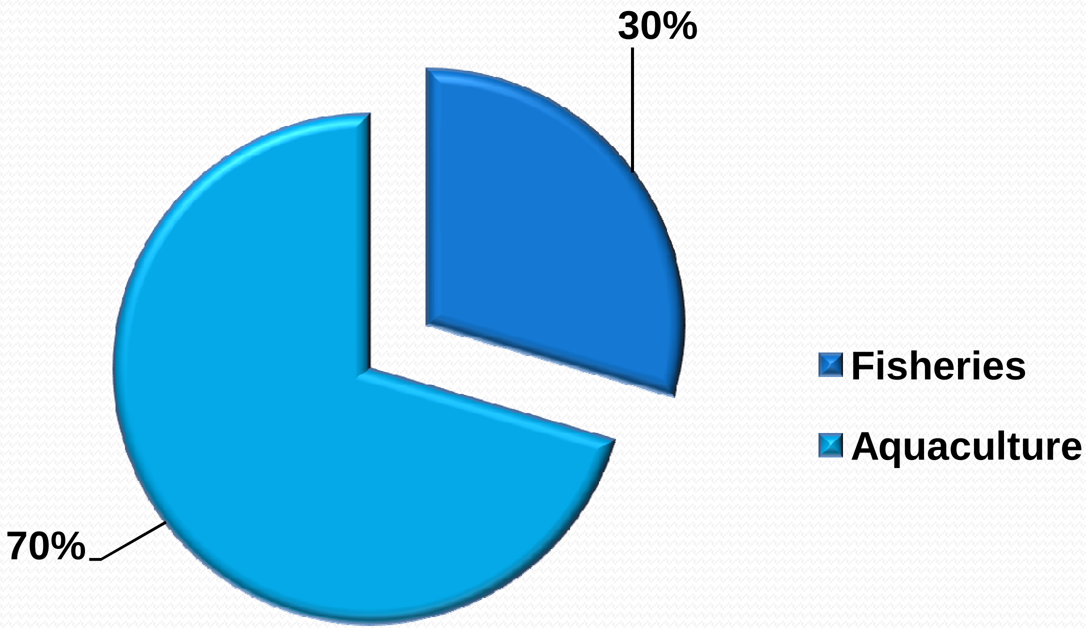
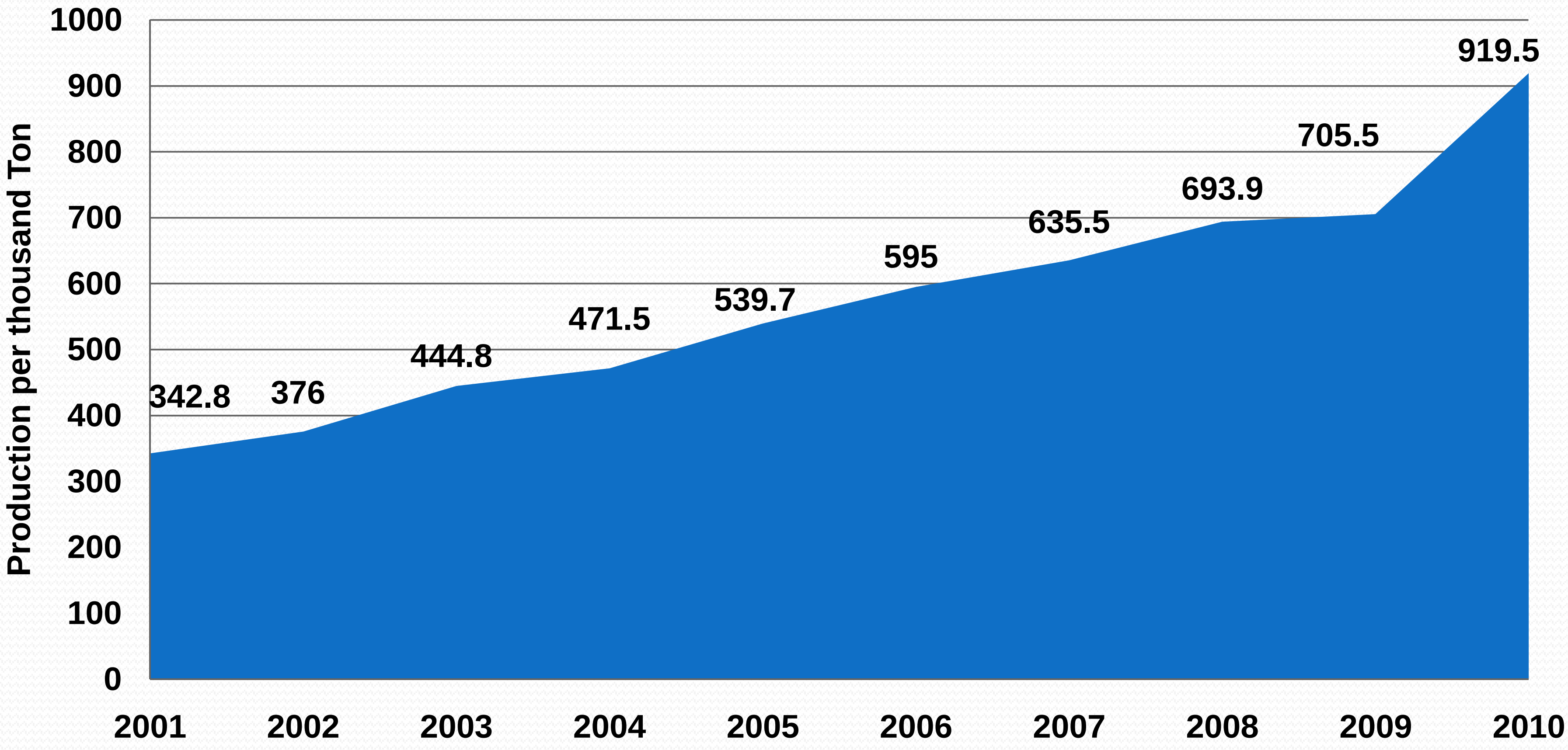
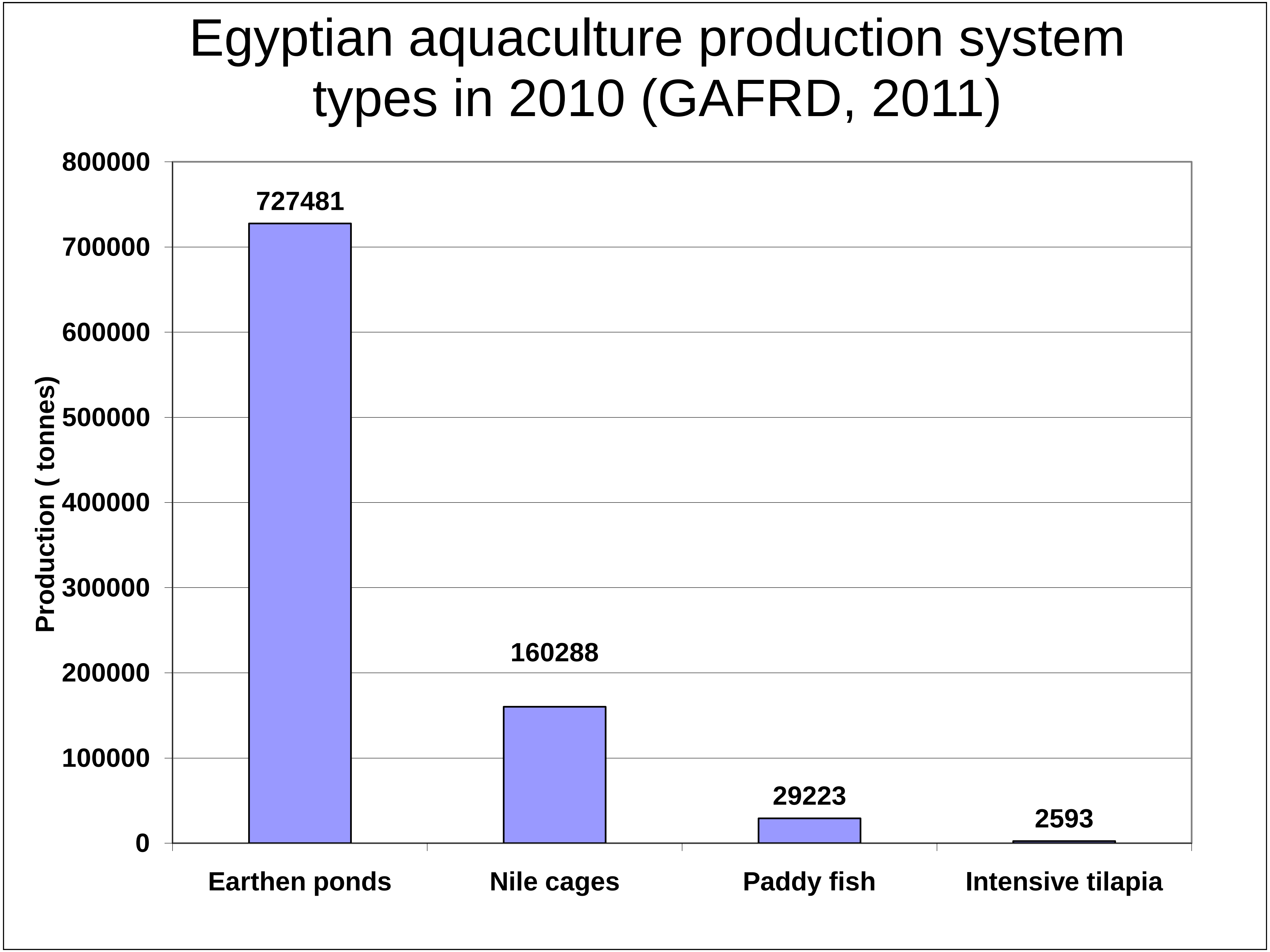
Introduction

Egyptian fish landing production in 2010 for the total 1,304,794 tons (GAFRD, 2011)

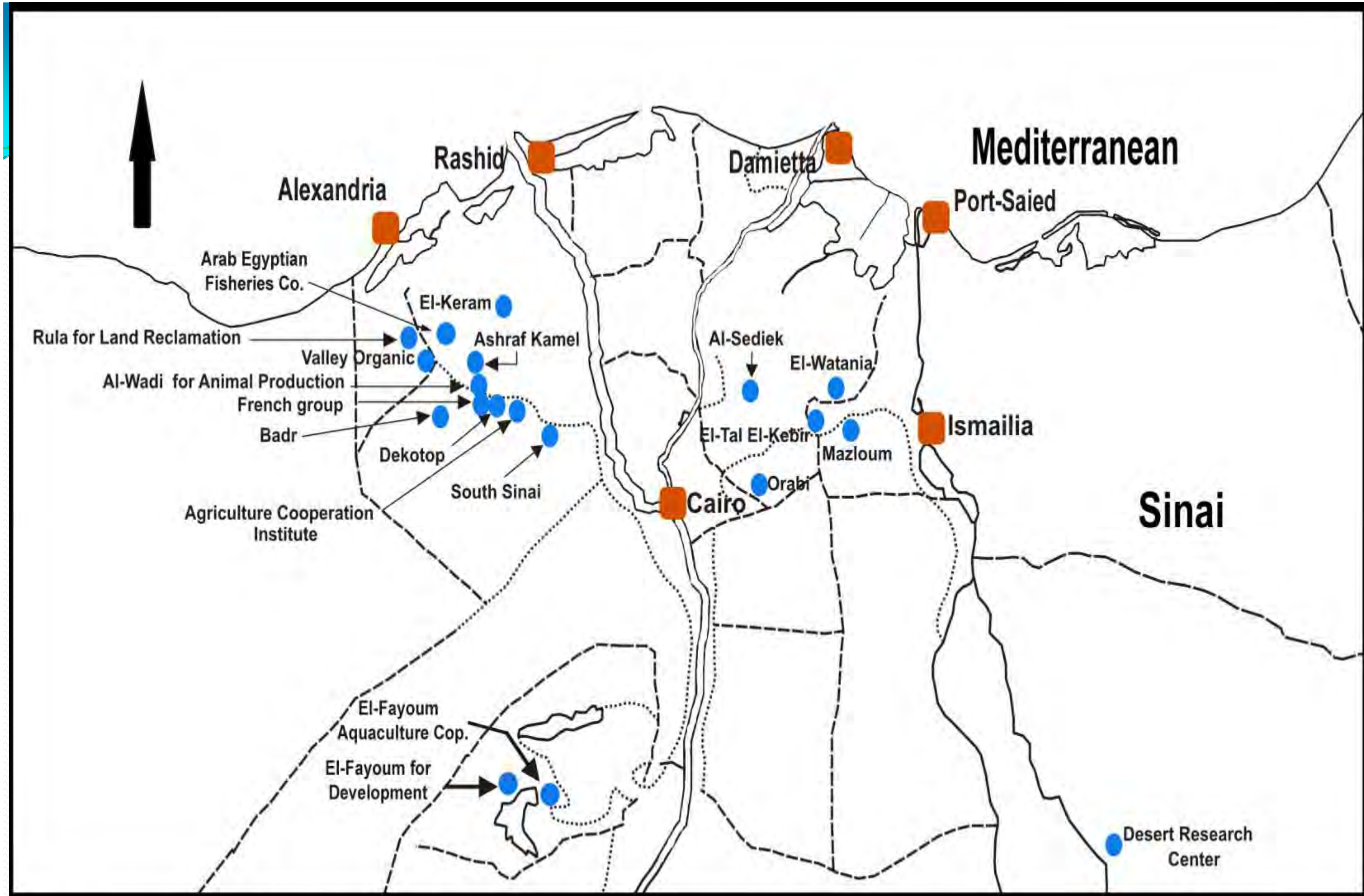


Aquaculture production trend in Egypt for the period 2001-2010 (GAFRD, 2011)





Egyptian aquaculture production system types in 2010 (GAFRD, 2011)
Production (tonnes)
800000
700000
600000
500000
400000
300000
200000
100000
0
727481
160288
29223
2593
Earthen ponds
Nile cages
Paddy fish
Intensive tilapia



Egyptian desert intensive fish farms using underground water

City Fish farm

Aquaculture Consultant Office (ACO)
Design : Mahmoud Asfoor
eng.asfoor@yahoo.com


Rula for Land Reclamation
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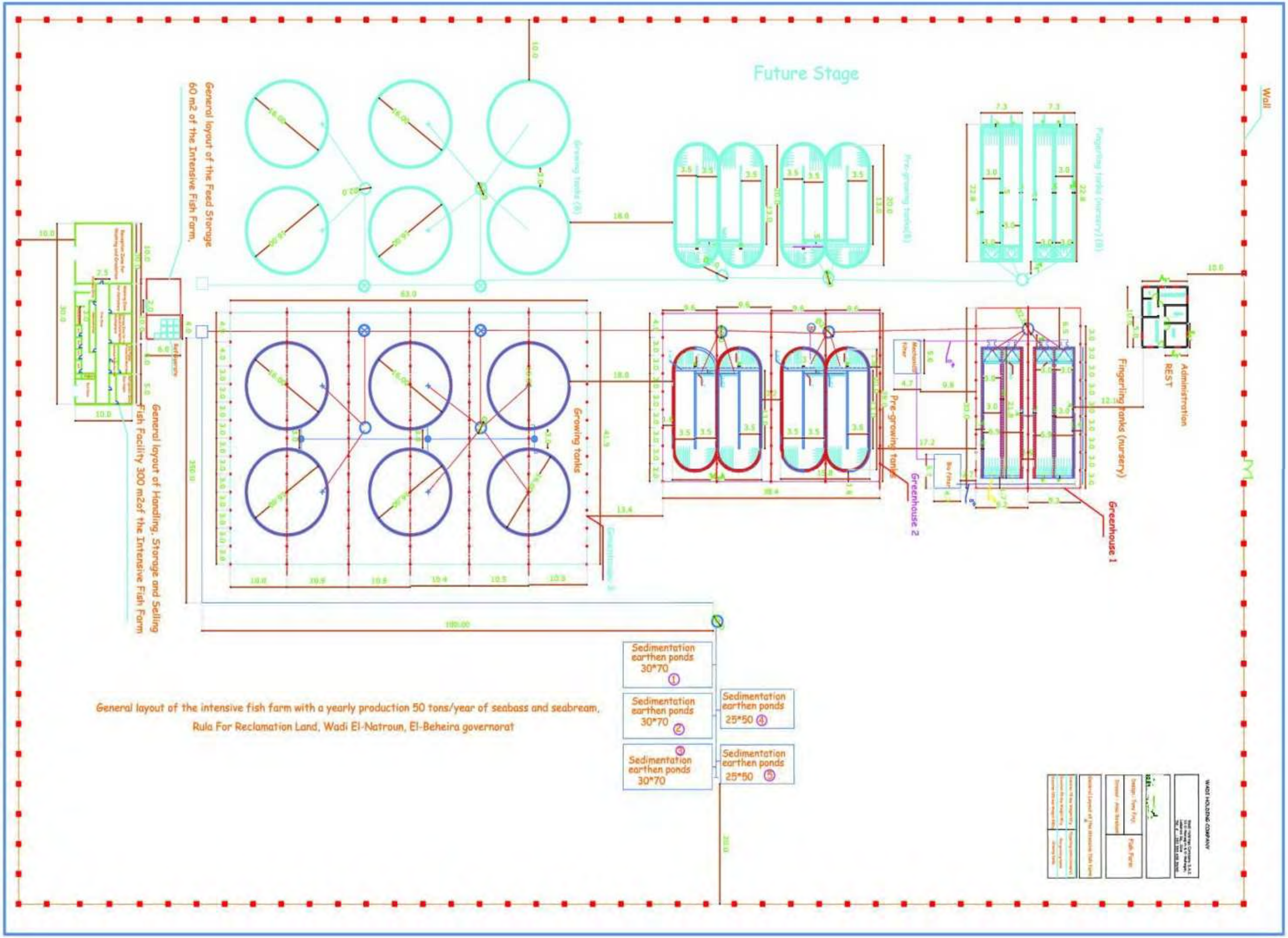
Google earth

Rula For Land Reclamation, Wadi Group, first trial of sea bass rearing in 2008



General layout of the intensive fish farm with a yearly production 50 tons/year of seabass and seabream,
Rula For Reclamation Land, Wadi El-Natroun, El-Beheira governorat

Nile tilapia, Red tilapia and Fresh water prawn culture trials in 2008-2009, using underground water (2600 ppm) and integrate the effluent fish farm water to the irrigation of the olive trees (3500 feddans).

Underground water (salinity 26000 ppm-26℃) has been used since 2008 to produce seabass and seabream at production level in 2010–2012 (17 to 33 Kg/m^3).

1

2

3

4

5

6

Underground water (salinity 26000 ppm-26 ℃) has been used since 2008 to produce seabass and seabream at production level in 2010–2012 (17 to 33 Kg/m^3).

10

11

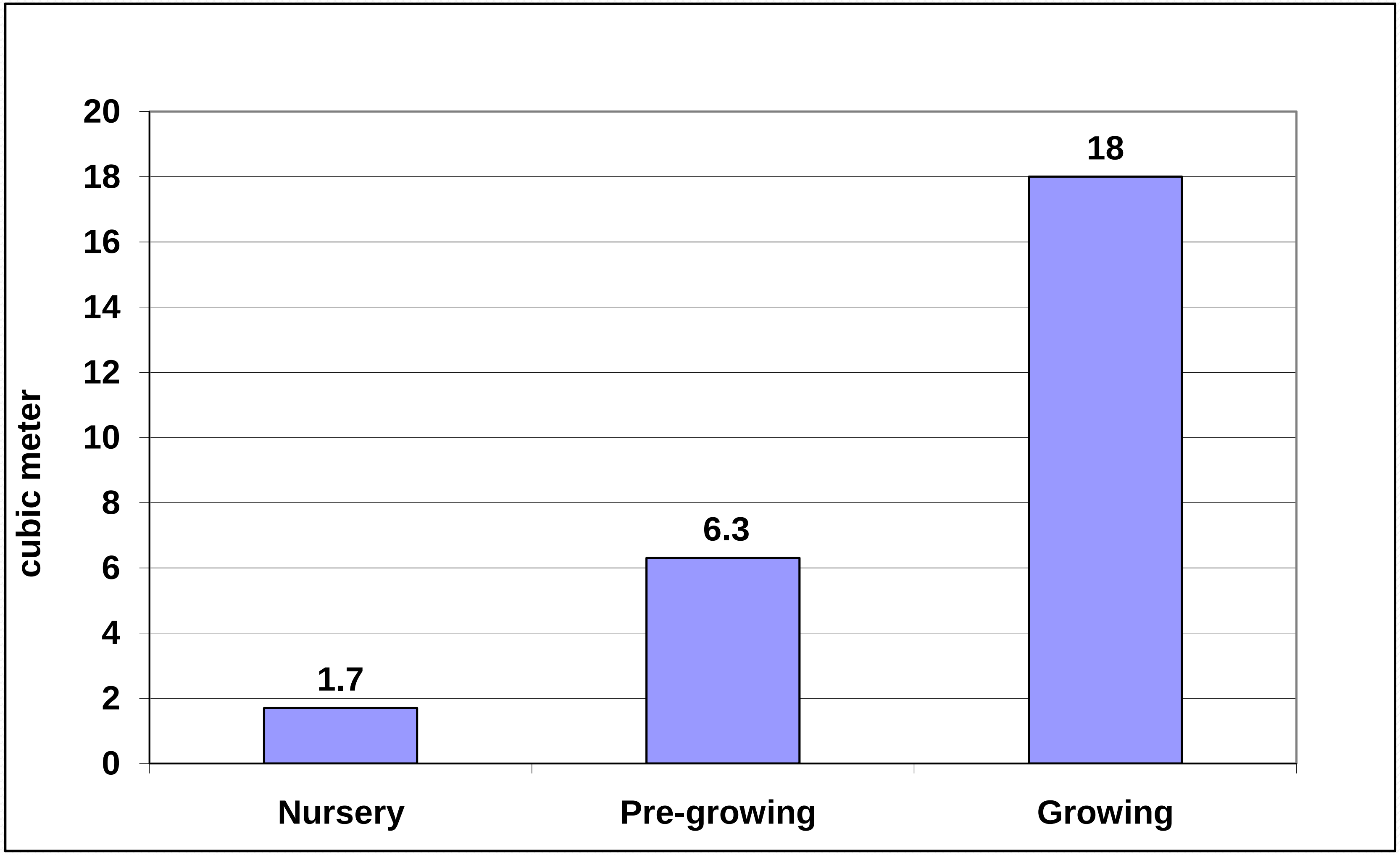
12

13

14

15

Estimated water consumption for the three production growing stages (nursery; pre-growing and growing) per kilo gram of European Seabass in Rula Intensive Fish Farm, Egypt.



RAS in Rula for Land Reclamation Co

Biofloc Trial

Theory

- Fish excrete ammonium (NH_4^+) (waste product of protein metabolism).
- With the right ratio of carbohydrates and ammonia (C:N) and intensive aeration all ammonia is absorbed and used by bacteria.
- These bacteria accumulate around particles, forming flocs.
- These protein-rich flocs are eaten by tilapia and shrimps.

Materials

1-Two round concrete tank with diameter (16 m) with total Volume ($200m^3$) (Tank No. 34 and No.Tank 36) equipped with strong aerators (2 HP paddlewheel: 4.4 kg O_2/hr)

Materials

2- Two sources of carbone were used from (Vinasse and Starch).

Materials

3- Red Tilapia fry (*Oreochromis urolepis hornorum* x O. *mossambicus*) source (k21 MH, Alexandria, GAFRD).

Materials

4- Tilapia feed (25% CP)

5- Effluent water of the intensive seabass / seabream fish farm.

Methods:

1- both tanks have been fill up with effluent intensive fish farm water (26 ppt salinity and high level of TAN).

2- Carbon source added to tanks

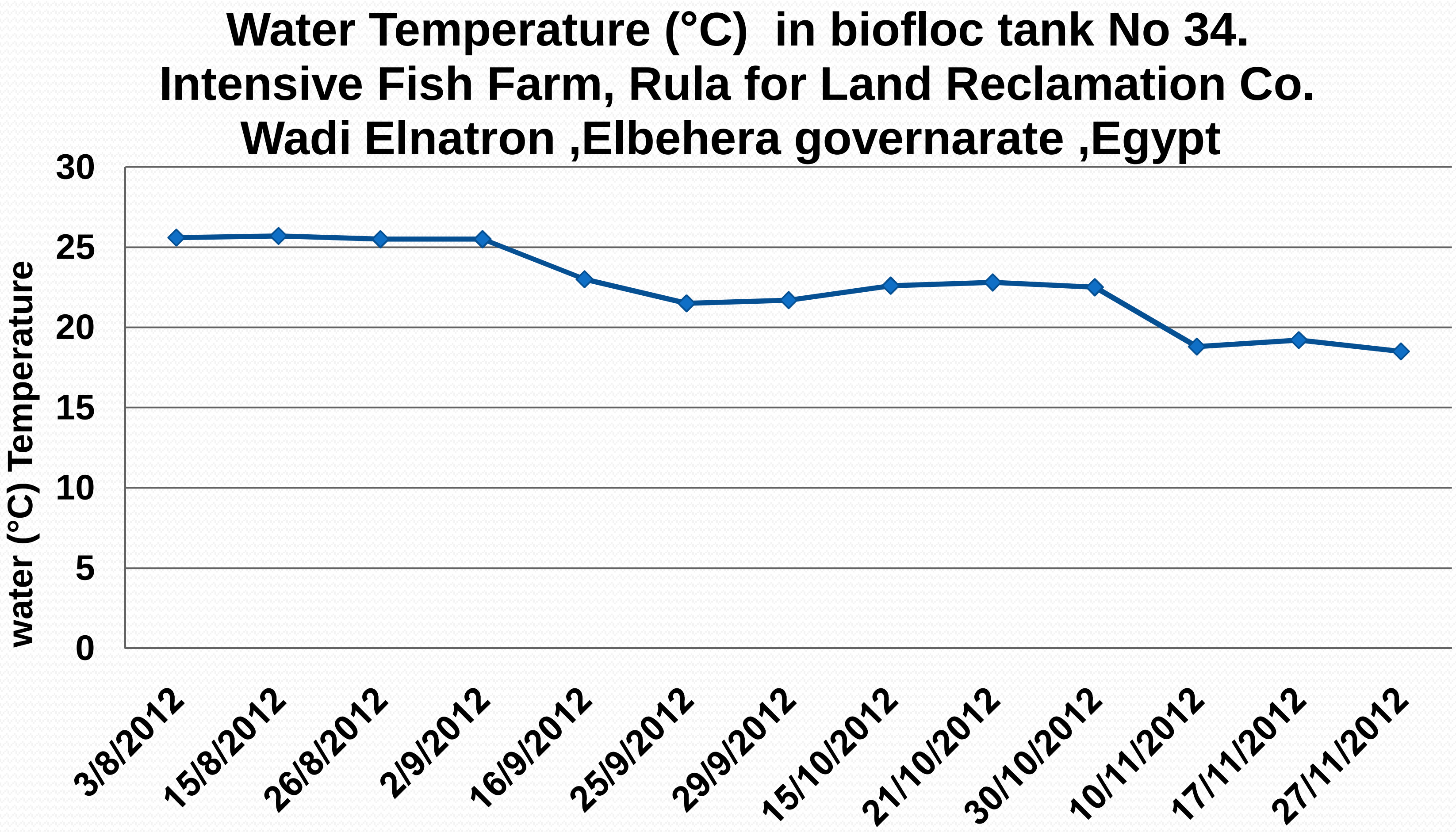
Tank 34	Tank 36
Starch	Vinasse

3- waiting tell formation of the biofloc and decrease of TAN level to be accepted for fish (0.03 ppmNH^3), then stocking red tilapia fingerlings.

Stocked red tilapia fingerlings and average weight		
Tank Number	**Tank No. 34**	**Tank No. 36**
Number of fingerlings	**9000**	**6000**
Average weight (gm/fish)	**70**	**210**
Initial biomass (kg/m^3)	**3.0**	**6.3**

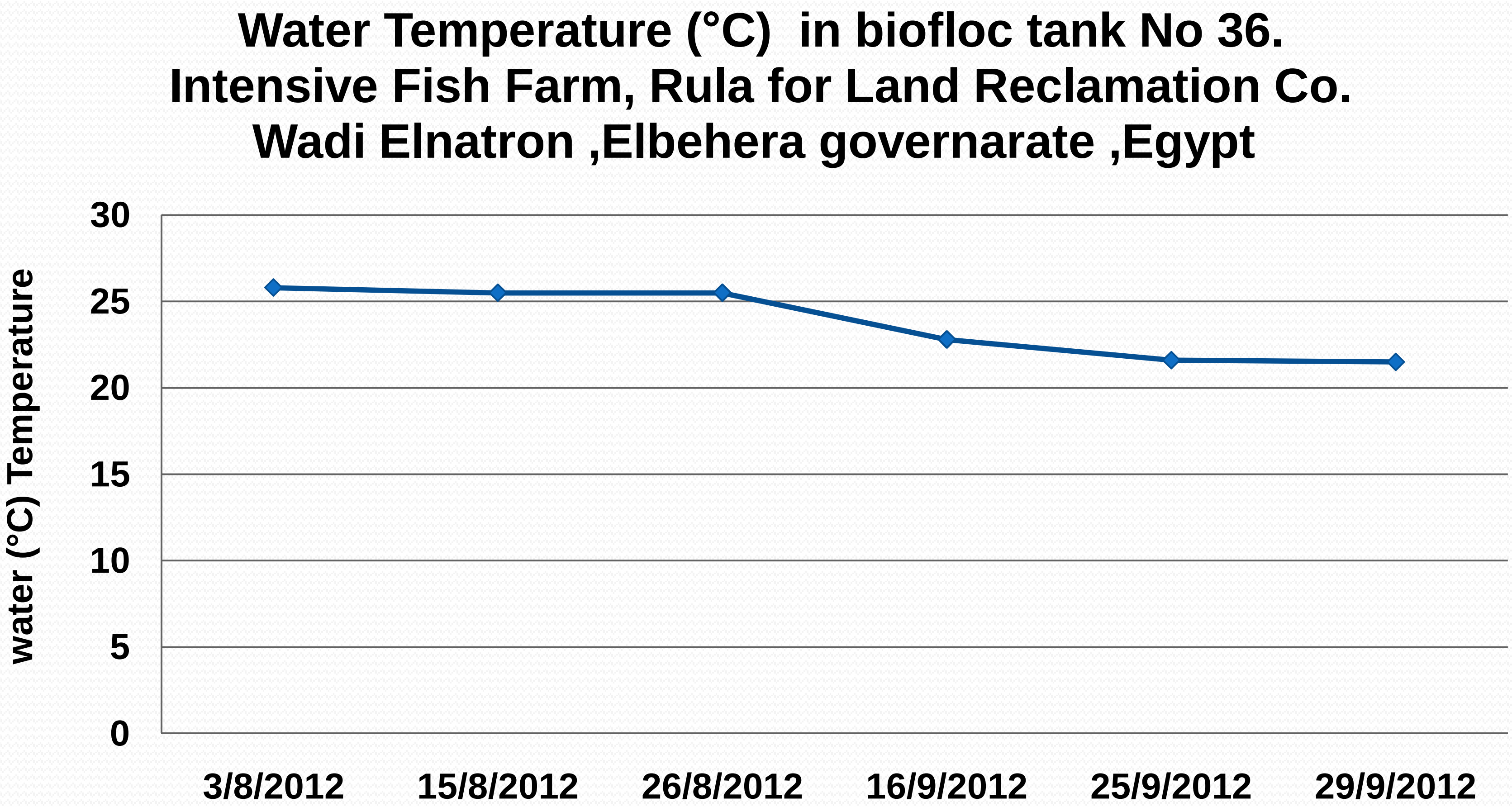
Management

Water quality (temperature)



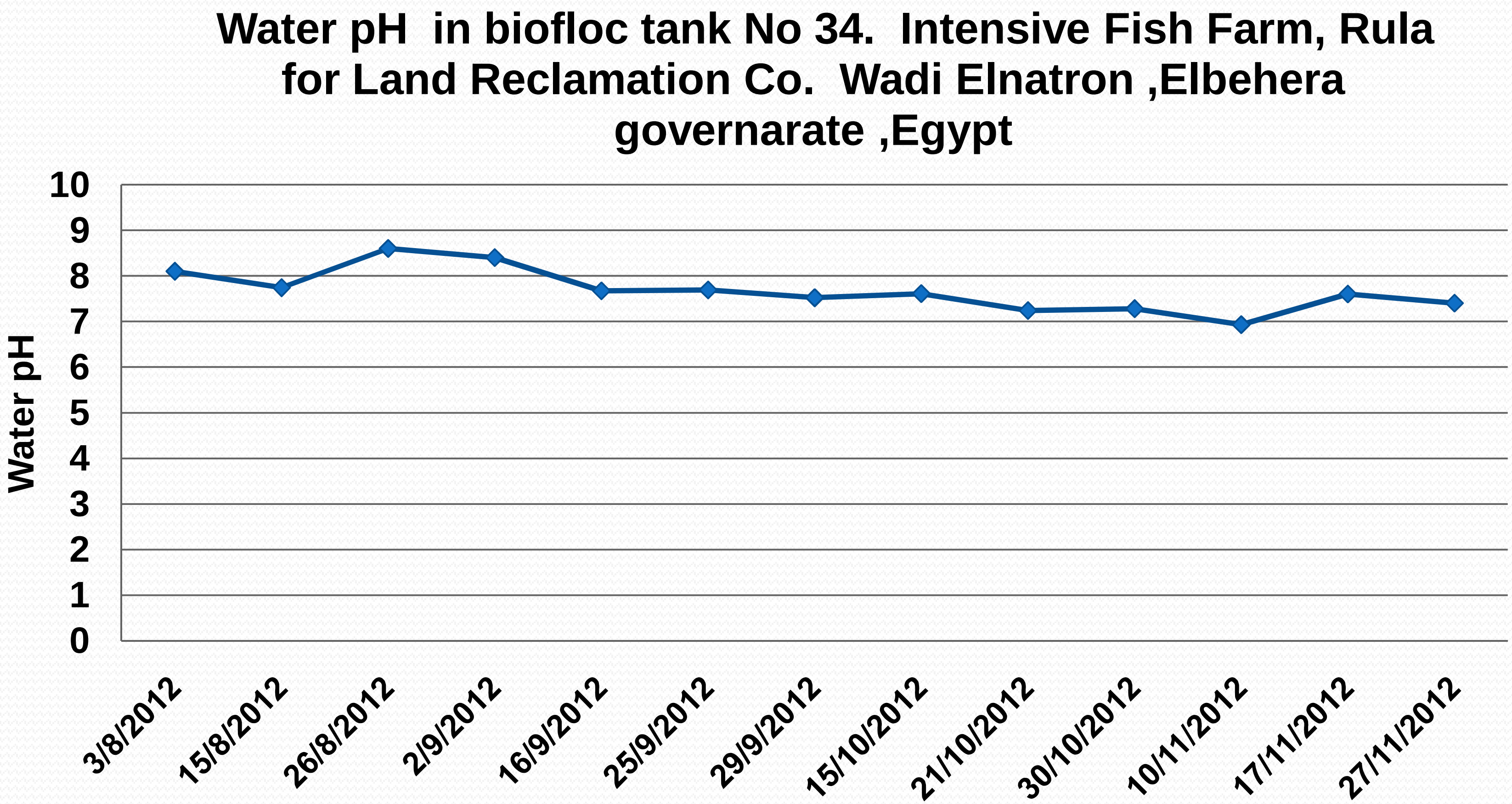
Management

Water quality (temperature)



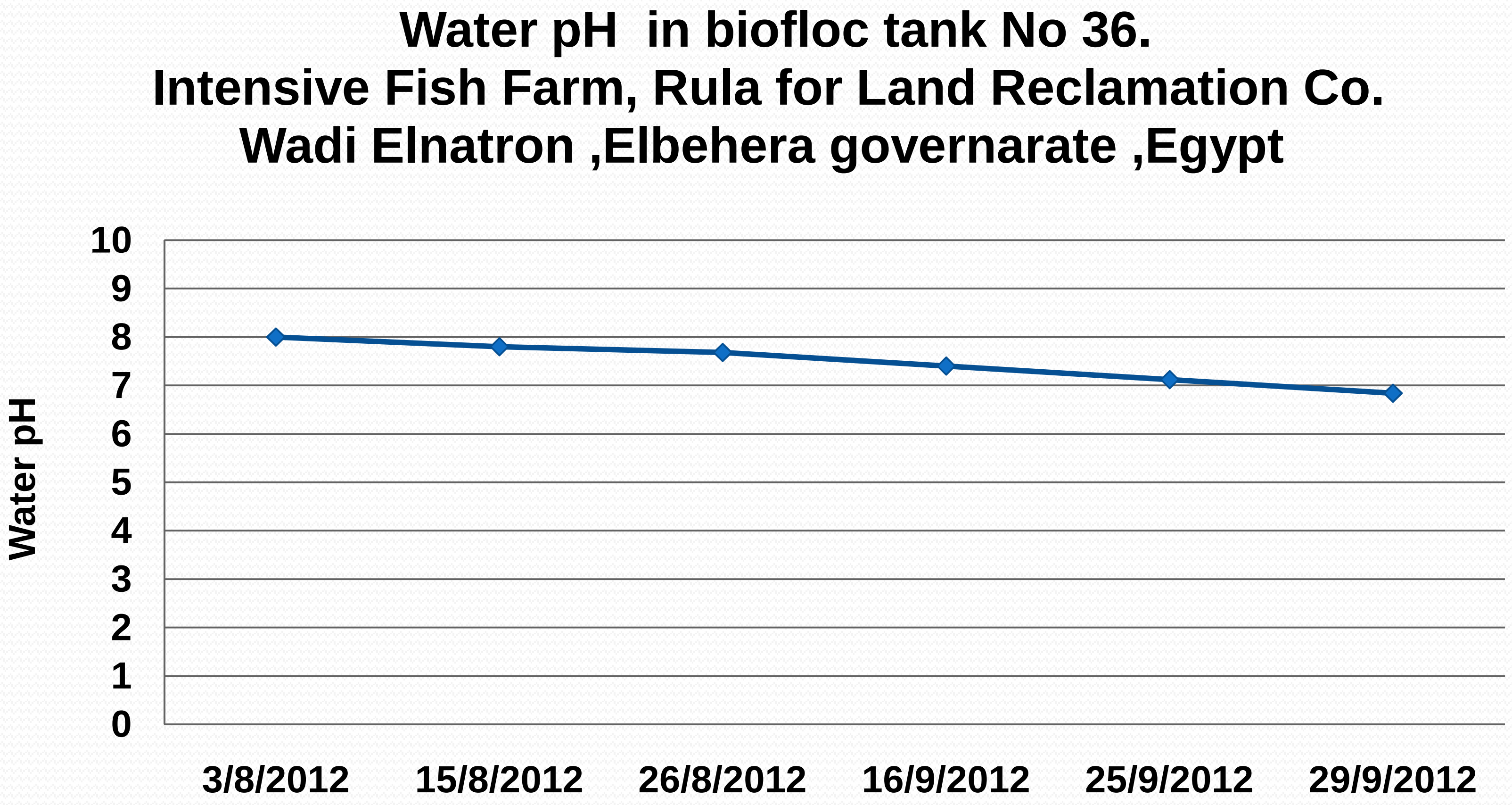
Management

Water quality (pH)



Management

Water quality (pH)



Management:

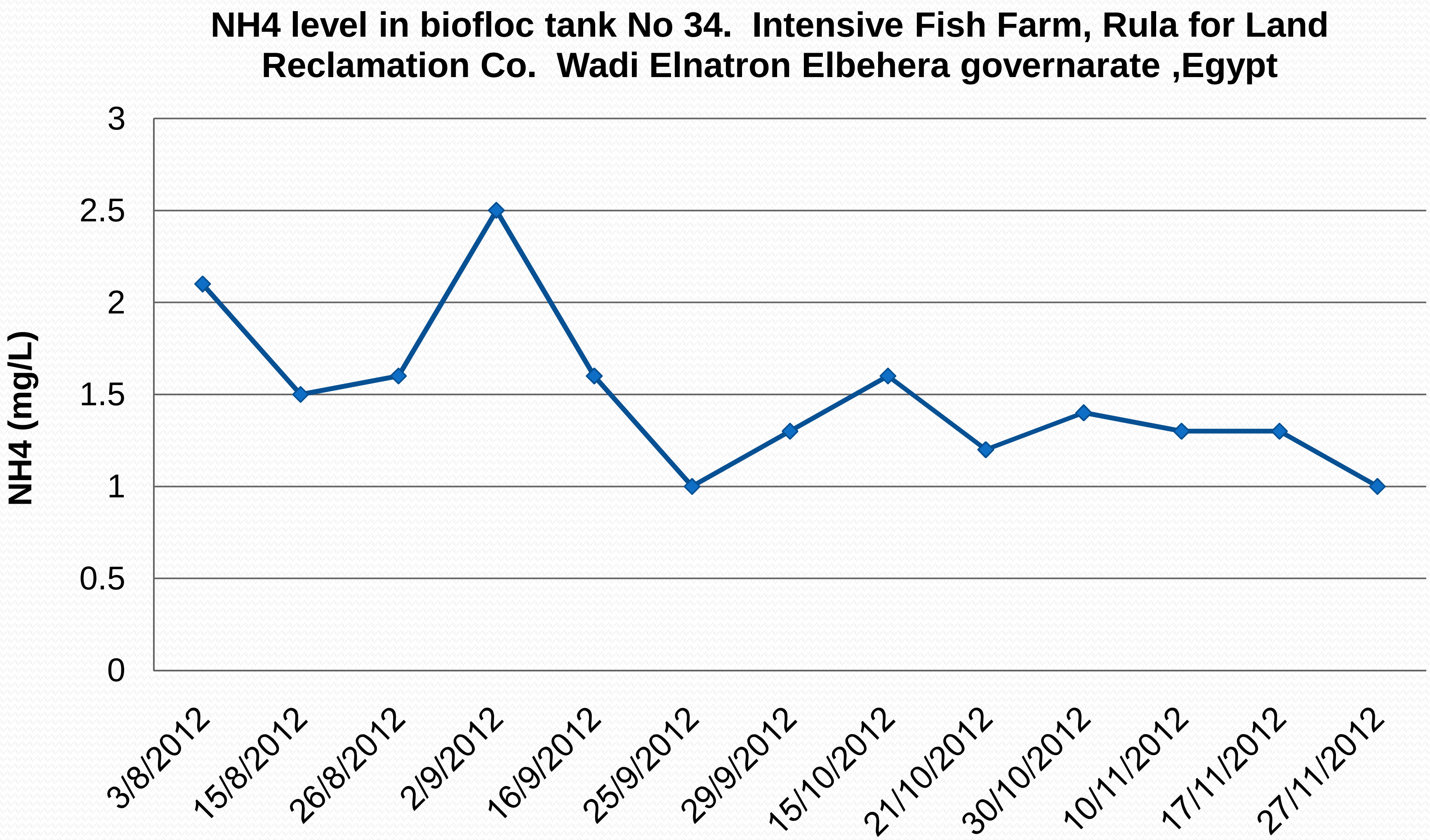
Water quality (O_2)

Continuous aeration to guarantee:

- Saturation of the oxygen level during the culture period.
- Good distribution of the biofloc particles and added carbon (starch or Vinasse).

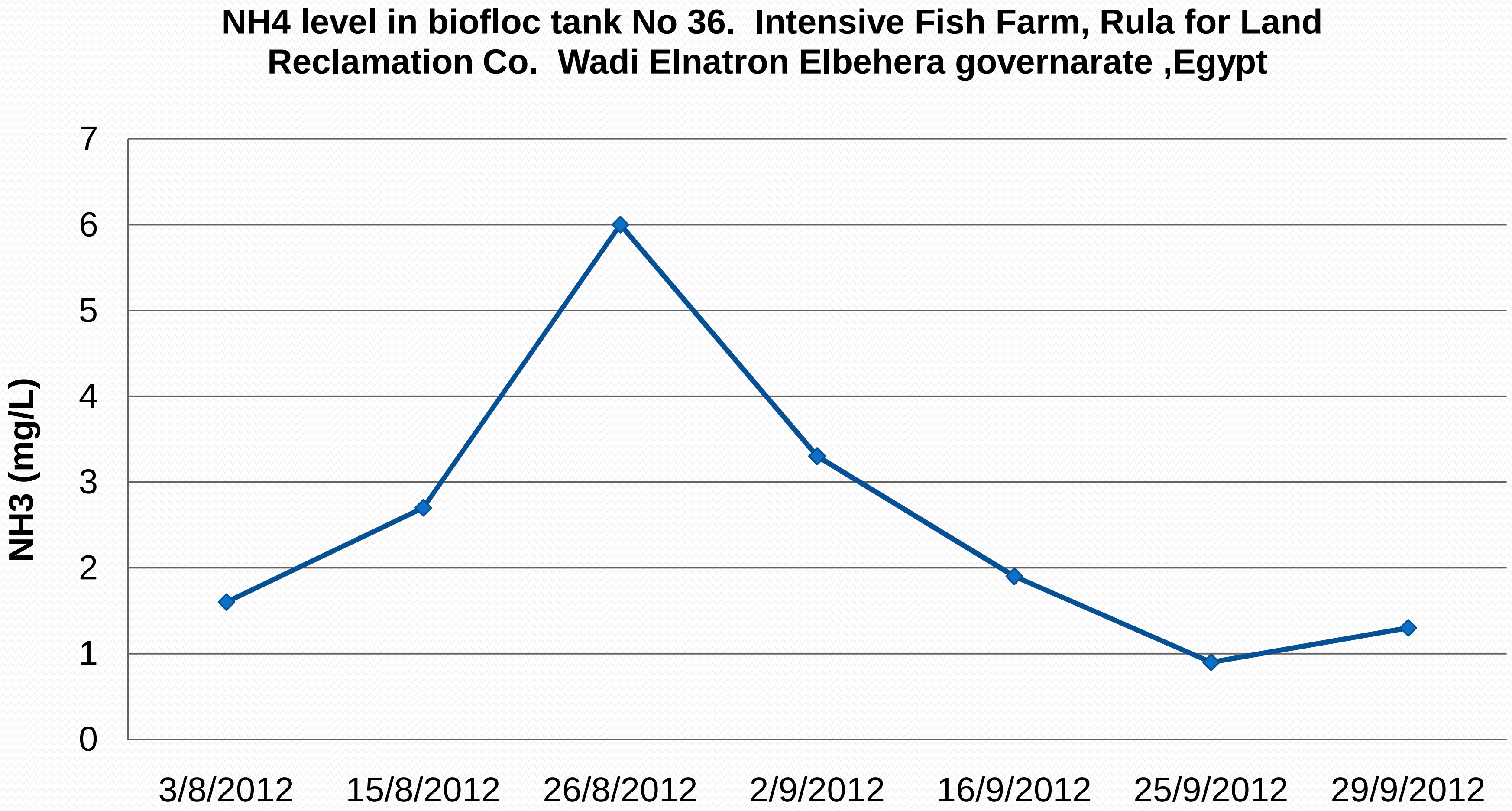
Management

Water quality (NH4)



Management

Water quality (NH4)



Management

Feeding

- Feeding frequency according to feeding tables.
- Feed only 80% of the recommended amount as fish also feed on biofloc.
- Feed with low level protein feed 25 % ?

Management

C:N ratio

1-Maintain the C: N ratio during the culture period by testing the TAN level every week

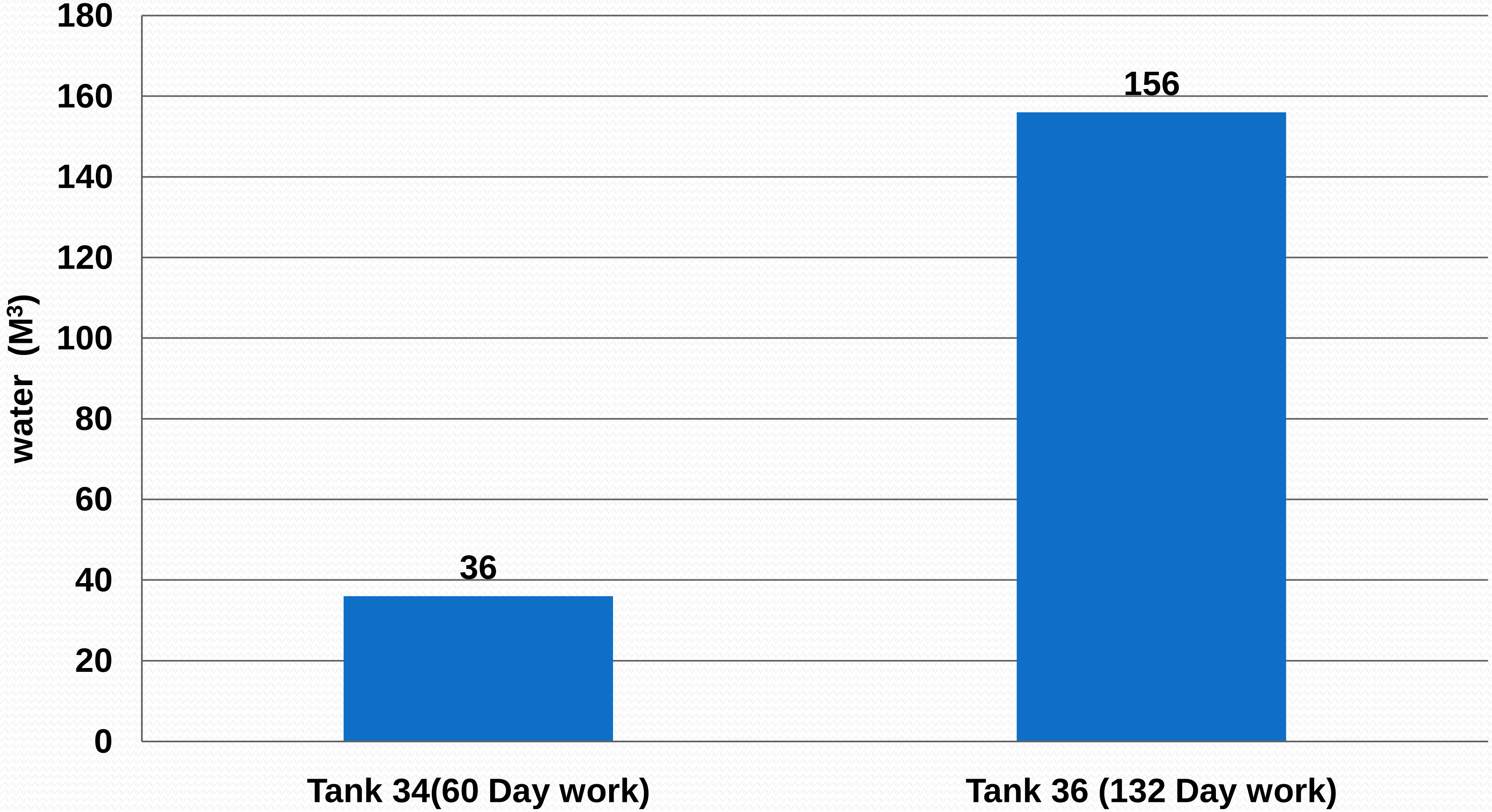
2-Adding carbon (Starch or Vinasse)

Management

Water Exchange

- Only add water to compensate for loss due to evaporation.
- Drain some excess biofloc (sediment).

Water Exchange (m^3) in biofloc tanks No. 34 and No. 36



Results:

Tank 34

- No of fish: 9000
- Minimum weight: 68 gm
- Maximum weight: 320 gm
- Average weight: 176.0 gm
- Stocking Rate: 7.3Kg /m^3 (based on water volume 200 m^3)
- Initial weight 70 gm (1/8/2012).
- Average Growth Rate during 132 days: 0.80 gm/day

Results:

Tank No. 34

- Specific Growth Rate (SGR) during 132days :0.69%
- Survival Rate during 132 days: 92.14 % (707 dead fish).
- Total biomass per tank: 1459.6 kg/tank (30/9/2012).
- Stocking Rate: 7.3Kg /m3 (based on water volume 200 m3)
- Total feed consumed till 30/9/2012: 1462 kg
- Fish feed conversion ratio (FCR): 1:1.66

Results:

Tank No. 36

- No of fish: 6000
- Initial weight 210 gm (1/8/2012)
- Minimum weight (end of experiment) : 144 gm (30/9/2012)
- Maximum weight (end of experiment): 512gm (30/9/2012)
- Average weight: 293.4gm (30/9/2012)
- Average Growth rate during 60 days: 1.38 gm/day

Results:

Tank 36

- Specific Growth rate (SGR) during 60 days :0.55%
- Survival rate during 60 days: 99.3 % (41 dead fish)
- Total biomass per tank:1748.4 kg/tank (30/9/2012)
- Stocking Rate:8.74 Kg /m^3 (based on water volume 200 m^3)
- Total feed consumed till 30/9/2012: 1000   kg
- Fish feed conversion ratio (FCR): 1:2


FASHION

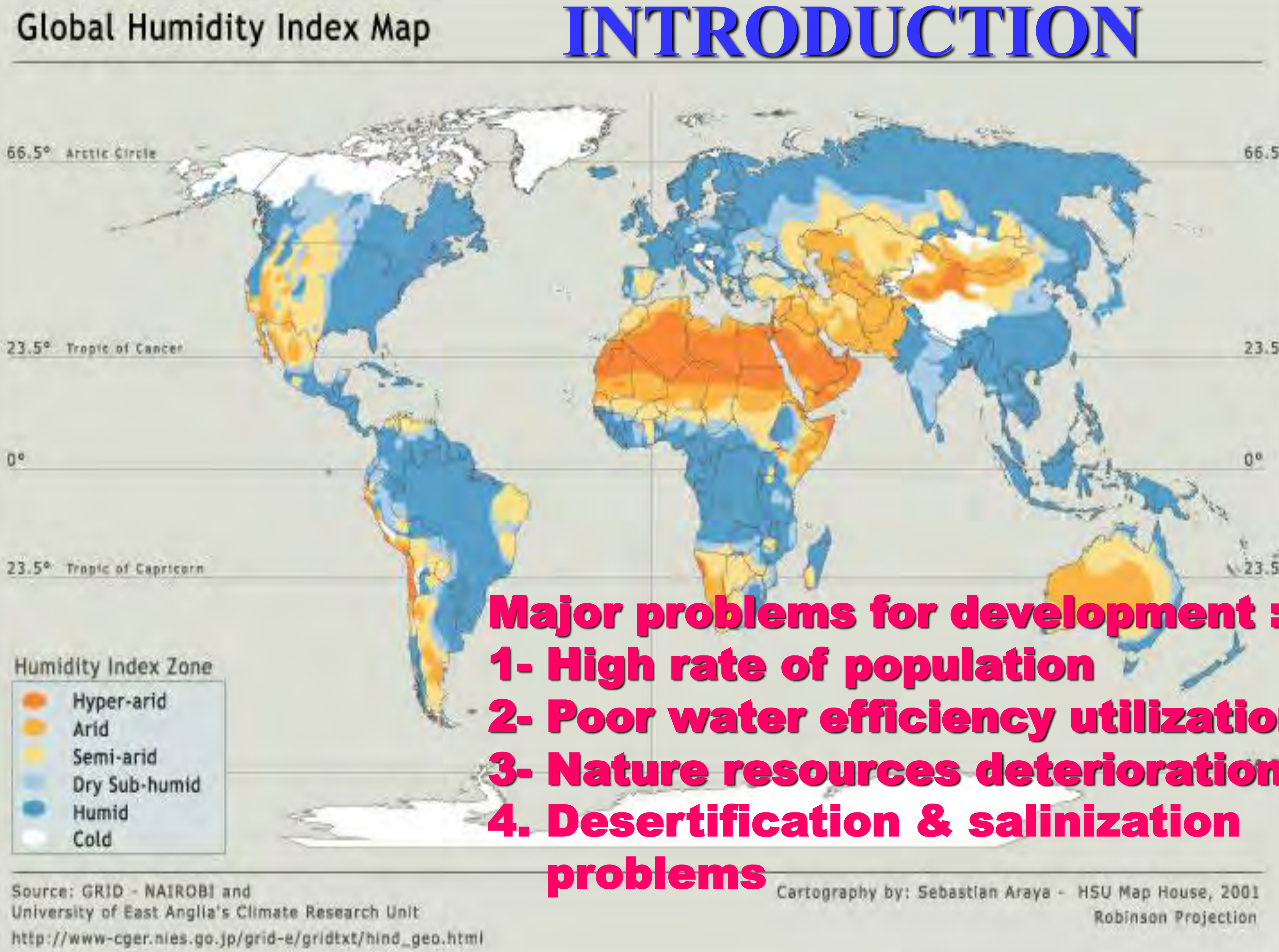

Thank you

Potential of halophytes and salt tolerant plants utilization as feed materials

Prof. Hassan M. El Shaer

Desert Research Center, Mataria, Cairo
Email : hshaer49@hotmail.com

INTRODUCTION



Major problems for development :

1- High rate of population

2- Poor water efficiency utilization

3- Nature resources deterioration

4. Desertification & salinization problems

ى المستوى العالمي:

المساحة المروية = 237 مليون هكتار

30 مليون هكتار تعاني من الملح بدرجة حادة

60 الى 80 مليون هكتار اخرى تعاني من مشاكل متوسط

في البلدان النامية:

ربع الاراضي المروية تعاني بدرجات متفاوتة من التملح

معدل خسارة الاراضي المروية: 1.5 مليون هكتار سنويا

ى مصر :

حوالى 2.5 مليون فدان زراعية تأثر بالملوحة

OBJECTIVES

* Draw attention on halophytes and salt tolerant plants utilization as cash crops
* Focus primarily on potentialities of such plants as feed materials for animal , poultry and fish

Definition & habitats:

- Plants grow in extremely saline habitats
- Have particular characteristics which enable them to evade and / or resist and tolerate salinity by various ecophysiological mechanisms.
- Plants grow in saline and water logged soils

*Found in: salt marsh systems along sea shores or around landlocked , inland lakes and flats with high evaporation, depressions

- **Salt resistance can involve**

- ***Salt tolerance*: involves physiological and biochemical adaptations for maintaining protoplasmic viability as cells accumulate electrolytes.**

- ***Salt avoidance*: involves structural with physiological adaptations to minimize salt concentrations of the cells or physiological exclusion by root membranes.**

➢COULD HALOPHYTES BE CASH CROPS?????

Economic benefits and uses of halophytes

1- Halophytes for food : Starch , Protein, Fat, Vit.

* *Aster tripolium* (salt aster),in Europe&Pakistan

* *Aster tripolium* (salt aster) → in Europe & Pakistan

* *Zizania aquatic* (wild rice) Western US & Canada

* *Salicornia sp.* & *Tripolium vulgare* ,West Siberia

2- Halophytes for feeds: Starch, Protein , Minerals

- *Atriplex Spp.*
- *Nitraira retusa*
- *Suaeda fruticosa*
- *S. monoica*
- *Prosopis tamarugo*

3- Halophytes for wood : Fire , Building , Crates

- *Tamarix amnicola*
- *Tamarix aphylla*
- *Mangroves*
- *Conocarpuse rectus*

4- Halophytes for fiber

Juncus rigidus & *Imperata cylindrical* in salt marshes

Juncus rigidus grown in saltmarsh soils of Siwa Oasis

5- Halophytes as wind breaks in the desert

* *Tamarix SP.*
* *Prosopis SP.*
* *Acacia sp.*

6- Halophytes : chemicals , pharmaceuticals , plastics

* *Zygophyllum alpum*
* *Artemesia herba alba*
* *Salsola kali*

7. Halophytes for landscaping : Beach sites, Roadsides , Housing areas , Dune fixations

Batis maritima

Haloc. strobaliceum

Avicennia germinans

Atriplex spp.

8- Ornamental halophytes: potting plants, gardening

* *Aster tripolium*
* *Batis maritima*
* *Tamarix nilotica*
* *Tamarix amnicola*

9- Environmental protection

* Many halophytes are used for coastline protections and turfs
* *Spartina aletrniflora* in China
* *Spartina martima* in Portugal

Halophytes as drug producers

The most important common halophytes:

Beta vulgaris, Gyperus spp., Desmostachya bipinnata, Halocnemum strobilacum, Nitraria retusa, Suaede spp., Salsola spp., Salicornia spp., Cressa cretice, Alhagi mauroum, Avicennia marina , Rhizophore nucronata, Zygophyllum album, Arthrocnemun macrostachyum, Limoniastrum monopetalum ,Limonium aixllare, Halopeplis perfoliata, etc.

Samphire

Salicornia offers "a strategic source of : food, vegetable oil(32%), fodder and meal

Salicornia oil might be used to produce Pharmaceuticals and cosmetics.

Salicornia meal additives for animal, poultry, fish : after oil extraction—contains around 40 % CP = soybean meal

Halophytes as animal fodders

More than 2000 halophytic plant species are identified
The most common halophytic plants :

- *1- Nitraria retusa* *2- Atriplex halimus*
- *3- Atri. semi- baccacta* *4- Atri. antidutale*
- *5- Suaeda spp.* *6-Tamarix mannifera*
- *7- Tamarix aphylla* *8 - Juncus subulatus*
- *9- Juncus rigidus* *10- kochia indica*
- *11- Arthrocnemum macrostachyun*
- *12- Alhagi maruorum* *13-Avicennia marina*
- *14- Halocnemm strobilaceum*
- *15-Zygophyllum album* *16-Salsola tetrandra*

Some common natural plants grown at Sea coasts in Egypt

جيراتالعادر)Artemisia monosperma(

المثنان)Thymelaea hirsute(

الحاد)Cornulaca monacantha(

الرتم)Retama raetam(

رطريط الأبيض)Zygophyllum album(

الغردق)Netraria retusa(

الهالوك)قنالجن( )Cistanche phelypaea(

خريزة)Salicornia fruticosa(

ائش البحر)Ruppia maritime(تتغذى عليها أنواع

من الأسماك


Coastal marshes
8. 11. 2001

Chemical constituents (%, on DM basis) of most common halophytes in the Red Sea coastal salt mashes zone

Plant species	DM	CP	CF	EE	Ash	NFE
Avicennia marina	33.2	10.5	13.9	3.30	25.9	46.40
Arthrocemom glaucum	39.1	6.33	17.3	1.98	39.7	34.69
Suaeda monaica	40.2	9.40	16.7	3.00	30.3	40.6

Source: El Shaer (2001)

Salt tolerant fodders

•Level 1 (about 5500 ppm):	
•Sorghum bi- color	Summer
•Pearl Millet	Summer
•Raygrass	Summer
•Alfalfa	Summer
•Cowpea	Winter
•Level 2 (about 8500 ppm):	
•Panicum spp.	Summer
•Napier grass	Summer
• Kockia indica	Summer
•Colara grass	Winter
•Fodder beet	Winter
• barely	Winter

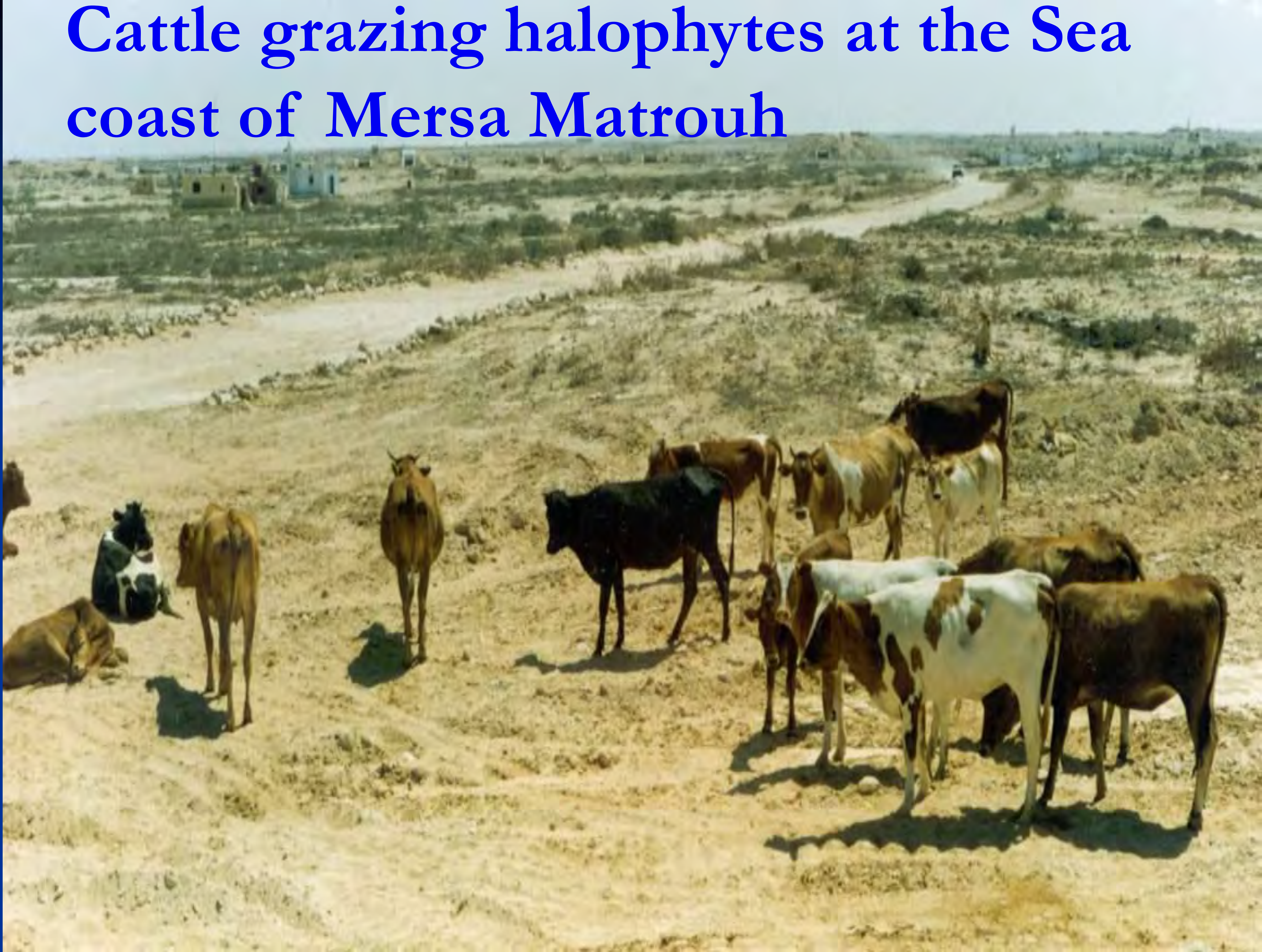
Level 3 (about 14000 ppm):

Tamarix spp., Atriplex spp., salicornia spp., *Suaeda spp*

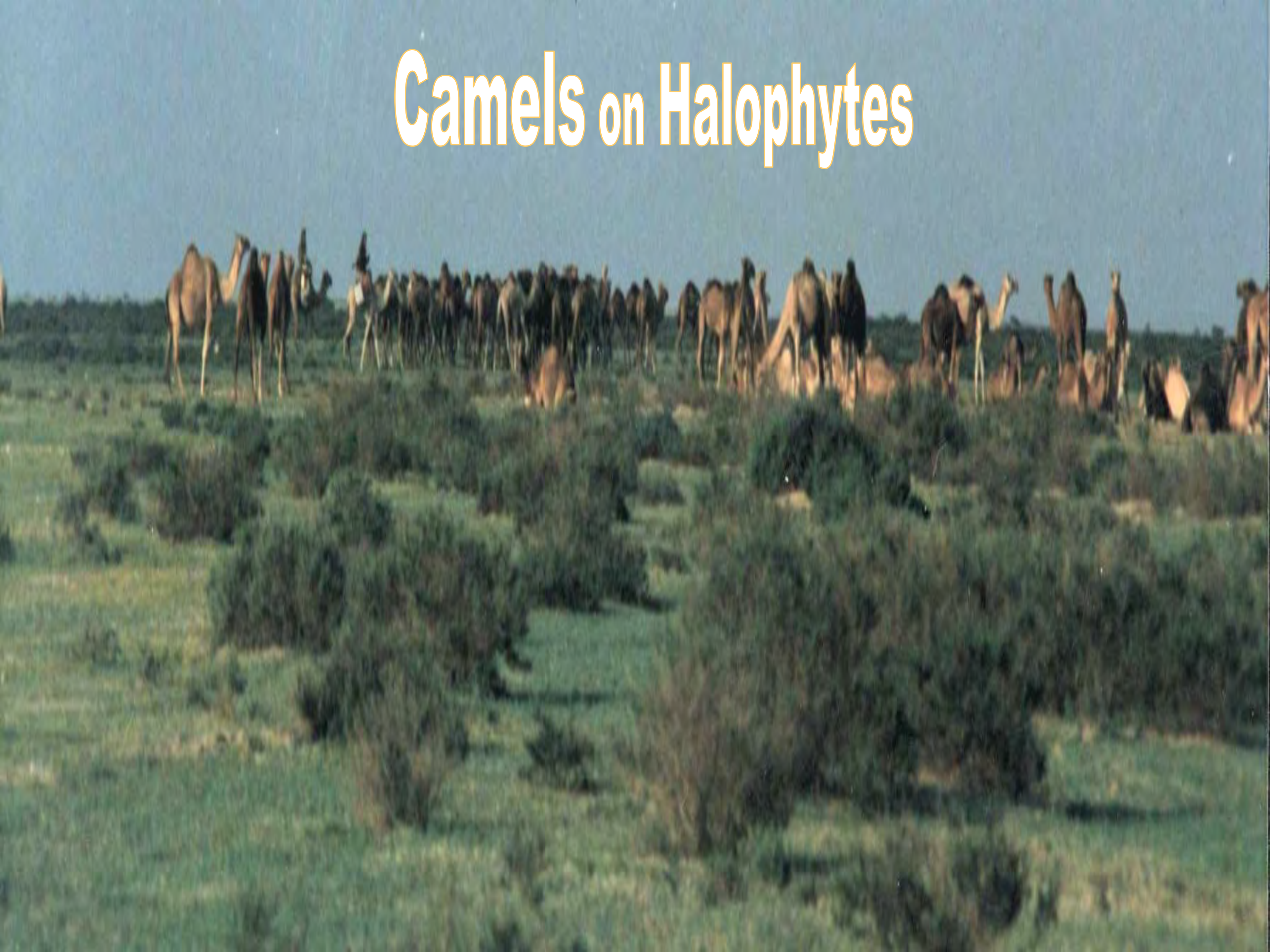
Chemical composition (%, on DM basis) of most common halophytes:

	PR	DM	Ash	CF	CP	EE	NFE
Nitraria restusa	A	38.1	30.2	31.5	11.3	2.55	24.45
Atriplex halimus	A	35.0	23.1	26.2	13.2	2.30	35.20
Salsola tetrandra	A	38.0	36.1	34.2	6.77	2.41	20.52
Sueada fruticosa	A	24.1	14.2	30.1	12.1	5.00	38.60
Tamarix aphylla	C	35.1	20.1	14.2	12.2	3.52	49.98
Halocnemon strobilaceum	C	30.1	40.1	17.0	6.92	2.15	33.83
Tamarix mannifera	G,C	42.1	25.2	13.0	8.15	3.11	50.54
Haloxylom salicornicum	Nil	45.1	18.1	29.5	17.5	5.71	34.19
Zygophyllum album	Nil	27.7	30.2	13.7	6.75	2.33	47.02

Cattle grazing halophytes at the Sea coast of Mersa Matrouh



Sheep & Goats grazing halophytes in Siwa Oasis


Camels on Halophytes

Meat traits from camels fed halophytes

1, BH, Berseem hay; AS, *Acacia saligina*; AN, *Atriplex nummularia*; AS-AN , were offered separately.

	BH	AS	AN	AS-AN
Flavor	4.33[a]	3.83[ab]	4.17[ab]	3.67[b]
Aroma	4.33[a]	3.50[b]	4.17[a]	3.92[a]
Tenderness	4.17[a]	3.50[b]	3.92[ab]	3.67[ab]
Juiciness	3.83[ab]	3.50[ab]	4.17[a]	3.50[b]
Palatability	4.17[a]	3.59[b]	4.15[a]	3.69[b]

Atriplex nummularia (Saltbush)

Proximate analysis and nutritive value of saltbushes (averages %, DM basis)

Atriplex spp.	DM	Ash	CP	NDF	ADF	ADL	TDN	DCP
A. halimus	34.2	22.7	12.6	66.7	40.7	9.29	55.0	9.90
A. leucoclada	25.6	31.7	11.1	36.9	29.1	11.0	46.0	8.00
A. vesicaria	32.0	30.0	12.2	46.9	28.1	9.89	41.0	8.40
A. farinose	48.9	34.6	8.13	45.1	27.2	8.55	36.0	5.62
A nummularia	24.0	23.2	17.2	58.4	40.1	8.72	51.0	10.4
A. canescens	32.0	19.6	14.2	61.2	45.2	8.11	50.0	10.2
A. semibaccata	34.0	17.5	14.0	45.0	35.1	8.60	49.0	10.0
A. glauca	42.0	24.3	12.9	40.4	31.7	8.12	47.0	8.80

Source : Gihad and El Shaer (1994)

البرسيم الحجازى فى اراضى شديدة الملوحة بجنوب سيناء

القطف الاسترالى فى اراضى شديدة الملوحة بجنوب سيناء

Siwa Oasis

المحاصيل العلفية عند مزارعى وادى سدر

FODDER BEET

BARLEY

SAFFLOWER

TRITICALE

المحاصيل العلفية عند مزارعى سهل الطينة

المحاصيل العلفية عند مزارعى سهل الطينة

نباتات ملحية يمكن إستخدامها فى المعاملات التى توضع في مناطق مختلفة

التحليل الكيماوى والقيمة الغذائية لبعض المحاصيل العلفية والشجيرات الرعوية المنزعة

المحصول	CP	ASH	%TDN	DMI/g/KgBW
البرسيم الحجازى	15.82	7.55	55	23
الدخن	7.18	11.49	57	19.2
السورجم	8.90	10.03	59	20.5
القطف	12.16	25.9	50	18
بنجر العلف	8.5	12.75	70	9.5
الليوسينيا	22.08	7.51	68	17
الاكاسيا	12.25	8.5	48	16
البانيكم	7.26	11.96	58	21

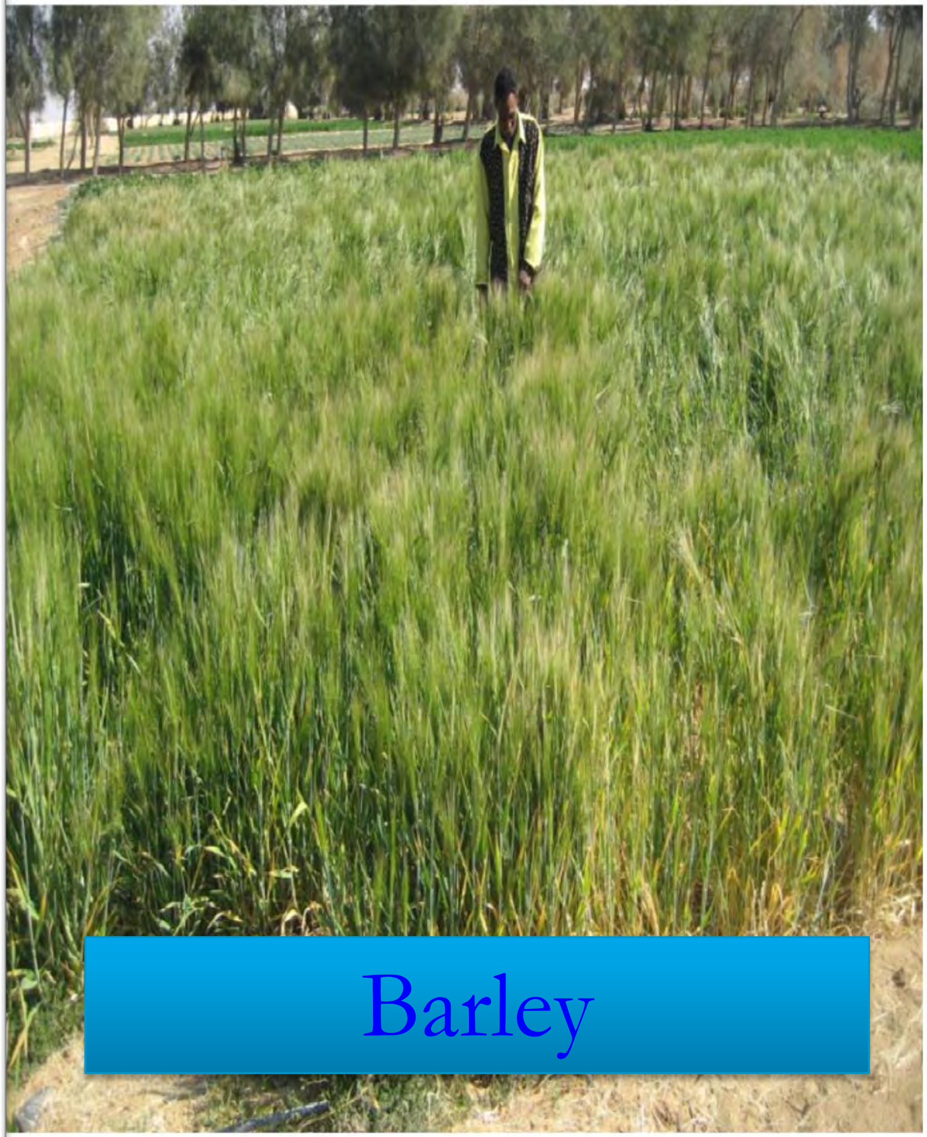
Inter- cropping halophytes with salt tolerant fodder crops

Fodder crops production under Package of water management practices in Al-Tina plain area

Fodder crops production under Package of water management practices in Al-Tina plain area

Gated Pipe Irrigation System in Ras Sudr

FODDER CROPS AT THE BEDOUINS FARM, RAS SUDR



السورجم عند أحد مزارعى وادى سدر

بنجر العلف عند أحد مزارعى وادى سدر

Limitation of halophytes as fodders

Poor utilization of some halophytes could be :

1- High ash content , particularly Na, Ca and silica

2- Higher NDF, ADF, ADL

3- Anti-nutritional factors such as tannins, alkaloids, saponins, etc

4- Non- protein nitrogen (NPN) represents about 50%

Processing of halophytic & STP feed materials

1. Physical treatment (chopping, etc)
2. Dehydration :Hay
3. Anaerobic fermentation :Silage
4. Anaerobic and aerobic fermentation
5. Feed blocks

ماكينات تصنيع المكعبات الطفلية


Feed Blocks
based on Salt tolerant plants

تصنيع الاعلاف الملحية

- تصنيع السيلاج
- المكعبات العلفية

Using Fish Farm Effluent(FFE)


مشروع
إدخال بعض نظم زراعة
الأعلاف الملحية
في الأراضي المتأثرة بالملوحة
بجنوب سيناء
قطف
Atriplex









إنتاج البذور





Feeding poultry on halophytic materials

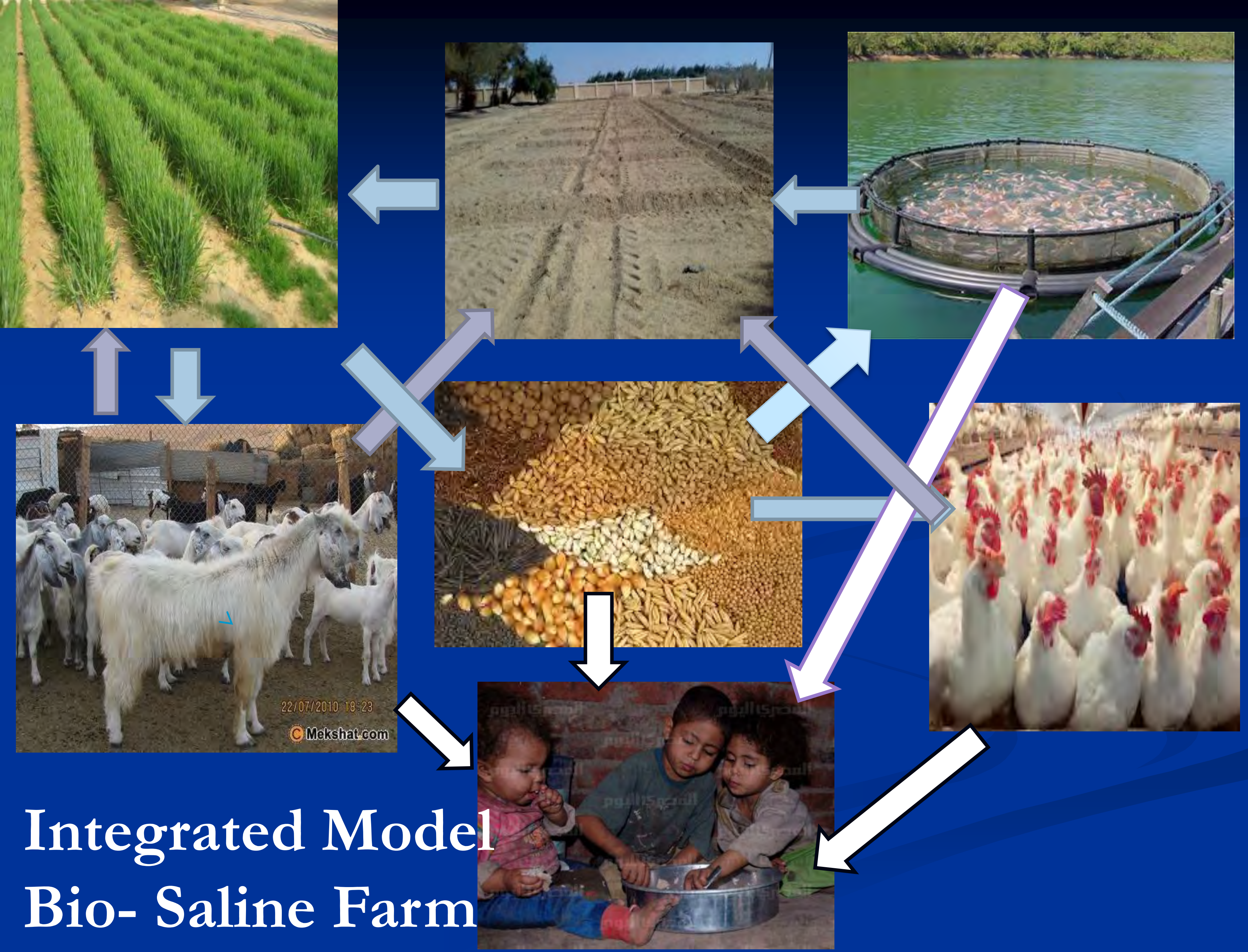
Feeding poultry on halophytic materials

Chemical composition of ATLM (on DM basis)

Items	Amin (1999)	Abdel Galil & Khidr (2001)
CP (%)	19.95	18.89
CF (%)	2.43	6.26
EE (%)	3.06	3.11
NFE (%)	40.91	41.33
Ash (%)	22.05	20.19
Ca (%)	1.40	1.99
P (%)	0.40	0.24
K (%)	3.20	4.82
Na (%)	5.90	8.96
Fe (ppm)	0	21.0
Cu (ppm)	78.0	28.0
Zn (ppm)	46.0	0

Recommended levels of ATLM and ACLM % in poultry diets

Species	Author	ATLM	ACLM	Type of feeding
Growing rabbits	Abd el Samee et al. (1992)	---	40	Wilting green leaves
Growing rabbits	Abd el Samee et al. (1994)	25	--	As green forage
Growing rabbits	El-Eraky and Mohamed (1996)	--	15	Pellet
Growing rabbits	El-Gendy (1999)	--	30	Pellet
Growing rabbits	Abd El- Galil and Khidr (2000)	--	20	Pellet
Growing rabbits	Abd El- Galil and Khidr (2001)	25	---	Pellet
Growing rabbits	Amin (1999)	6	---	Mash
Layer turkeys	Amin (1999)	12	---	Mash
Broilers	Amin (1999)	---	6	Mash



Integrated Model
Bio- Saline Farm

CONCLUSION

1. Many of halophytes & salt tolerant plants (STP) are available for utilization in many climates (arid, desert, tropical , etc.)
2. The necessity for local freshwater saving is obvious everywhere in arid &semi- arid regions
3. Some applications of halophyte & STP utilization are highly profitable, such as producing new human food and animal, poultry and fish feed materials , oil, drugs, etc.

THANK YOU





The 2nd Inter. Conf. " Optimum Utilization of Salt Effected Ecosystems in Arid Regions, 9 -12 Sept., 2013

Website: www.drc-conf2013.com

Nutritional and feeding Requirements in larval and juvenile feeds

Coppens International bv

- Employees: 100
- Widespread network of agents and distributors in 40 countries throughout the world
- High quality, innovative fish feed programs for every species of farmed fish

Anno Galema
General Director

Jeroen van Stokkom
Commercial Director

Marc Verkuyl
Export Manager Africa

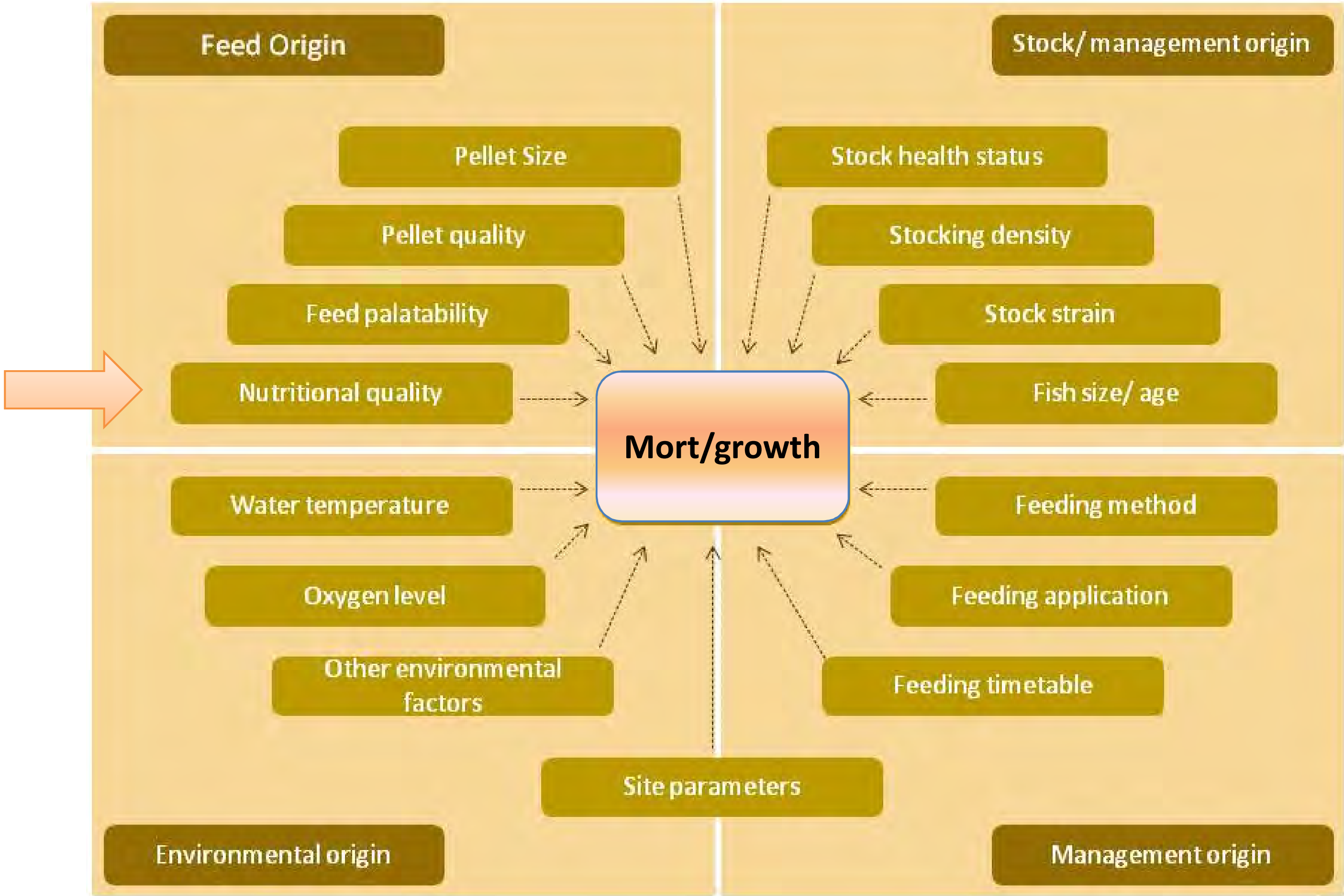
Nutrition and feeding

- Nutrition is the most expensive component in the intensive aquaculture industry,
- 50%-70% of operating costs.
- Feeding management is a necessary tool for success
- Hatchery 20%-30% operating cost.
- In hatchery survival and growth more important.
- Right larval development.

Problems with larvae and fingerlings

- **High mortalities**
- **Slow growth**
- **Deformities**

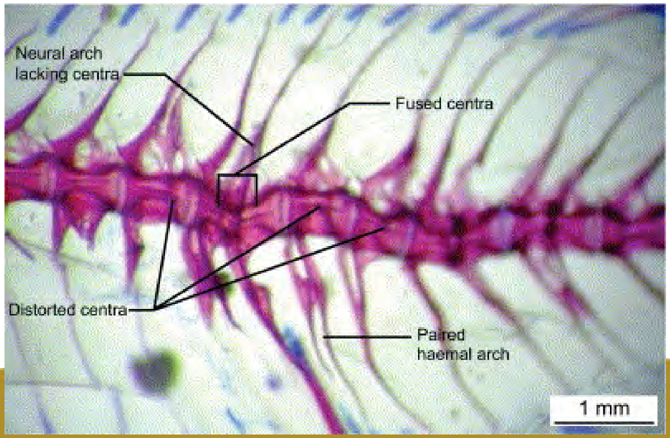
High mortalities & Slow growth



Problems with larvae and fingerlings

- **Deformities -**
  - ***Nutritional imbalances or deficiencies***
  - ***High water temperature during egg incubation***
  - ***Vaccination side effects***
  - ***Stress due to environmental conditions***
  - ***Inbreeding***

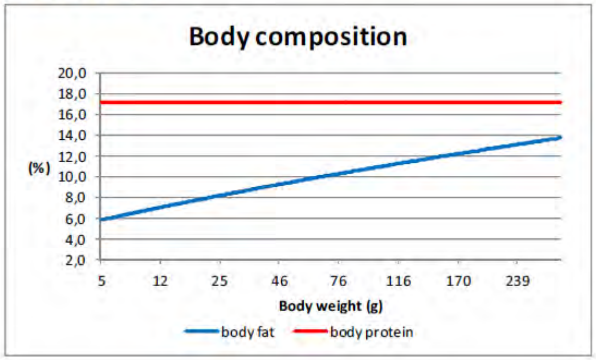
:		
Formula Code	A	B
	Fish meal	Crumble Excellent
Final Body Weight (mg)	696	1195
FCR	8.04	0.66
Percentage Mortality	86,7	1,0
Deformations (%)	100	2

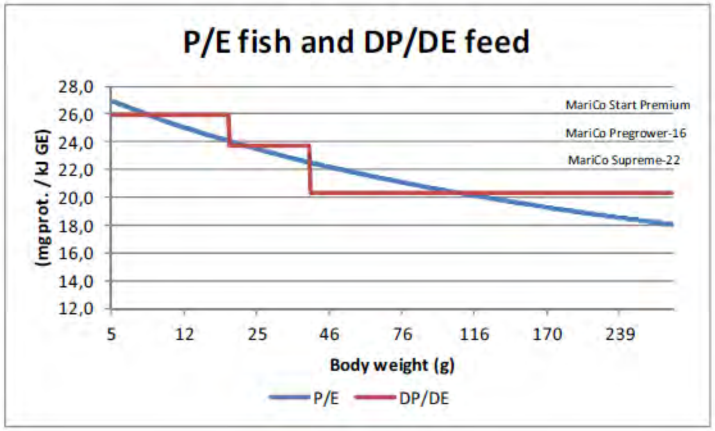


Digestive capabilities and nutritional requirements of larvae and fingerlings

- **Species Dependent**
- **Digestion and utilization is dependent on life stage**
- **High protein requirements at the beginning**
- **Low level of energy at the beginning**
- **Feed composition must follow requirements**
- **Protein/ fat ratio**
- **Phase feeding**

Development of body composition Sea bass





Raw materials

- **Fishmeal,** palatability (+++)
- **Animal by-products,** (+++)
- **Plant protein,** (++)
- **Fish oil,** energy, palatability (+++)
- **Animal fat, Plant oils,** energy (++)
- **Wheat, starch,** binding
- **Premix,** vitamins & minerals

Protein quality

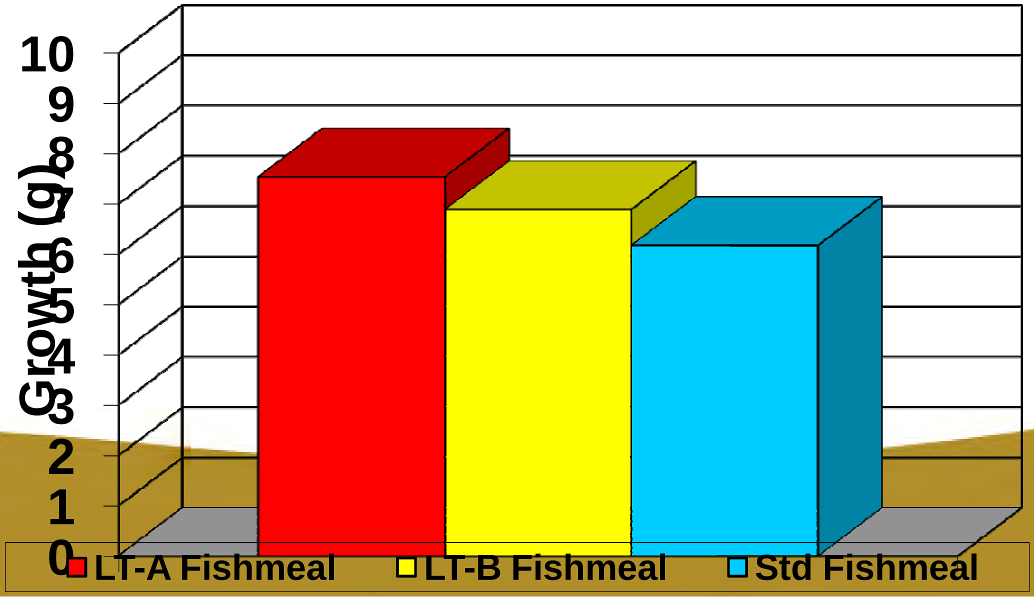
Protein most expensive dietary source.

- **Building blocks for meat**
- **Essential (non) amino acids!**
- **Quantity and quality**
- **Peptides**
- **What happens during essential amino acid deficiency?**

Fish meal

- Fish meal quality has a significant influence on the performance of larvae
- Performance was best with fish meal LT-A
- LT-fish meal B was not as good as fishmeal LT-A but better than standard fishmeal
- Protein utilization was best with fish meal LT-A
- Extrusion has no negative effect on the quality of fish meal

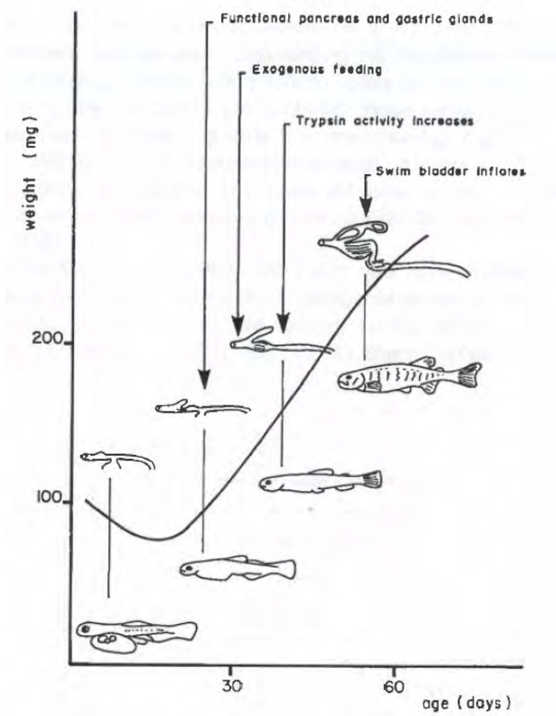
Trout 54 days experiment
15 ºC
weight 0.2-7gram

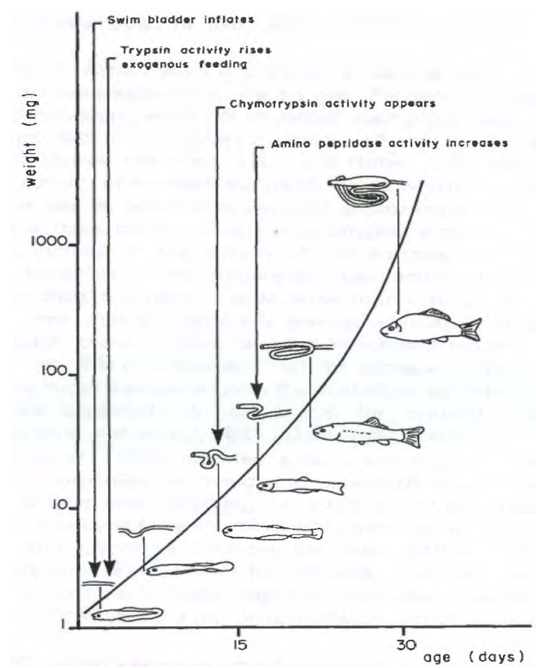


Protein requirement larval stages

- Tilapia 35–50%
- Carp 35-56%

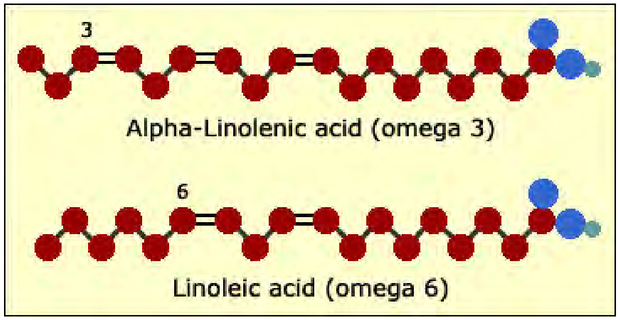
- Catfish 45-66%
- Sea bass 55-66%
- Barramundi 55-66%





Fat/ Lipids

- **Important energy source**
- **Protein sparing**
- **Essential fatty acids (EPA, DHA)**
  - ***Structural lipids, membranes***
  - ***Disease resistance***
  - ***Precursor of hormones, reproduction***
- **Phospholipids**
  - ***lecithin***



Fat requirement larval stages

- Tilapia 8-15%
- Carp 10-15%
- Sea bass 10-20%
- Trout 11-21%

Carbohydrate

- **Minor dietary energy source**
- **Carrier of nutrients**
  - ***Open matrix structure***
  - ***Absorb oil***
- **Firm, water stable pellets**

Vitamins and minerals

- **Fat soluble (A, D, E, K)**
  - ***Growth, reproduction, etc***
- **Water soluble (B-group and C)**
  - ***Enzyme systems, skeletal development***
- **Minerals (Fe, Cu, Ca, P, Mg)**
  - ***Red blood cell, oxygen transport, Enzyme systems, skeletal development***

Coppens Carpco Crumble

CRUMBLE EXCELLENT

- **high quality fish meal,**
- **yeast - immune stimulant (ß-glucans)**
- **wheat gluten; maize starch; fish oil**

Initial weight (g)	End weight (g)	Feed size (mm)
0,02	0,1	0,2-0,3
0,1	0,35	0,3-0,5

Analyses			Size
Protein	43	%	0.2-0.3 mm
Fat	9	%	0.3-0.5 mm
Crude fibre	1.2	%	
Ash	5.5	%	
Total P	1.1	%	

Coppens Tilapia crumble

VITAL

- **fish meal; wheat; maize gluten; wheat gluten; soya dehulled, extracted, toasted; fish oil**
- Feed contains high quality products
- Tasty and highly digestible
- Slow sinking behavior
- Easy hormone mixing

Analysis		Size	Analysis		Size
Protein	47 %	0.2-0.3 mm	Protein	46 %	0.5-0.8 mm
Fat	8 %	0.3-0.5 mm	Fat	10 %	0.8-1.2 mm
Crude fibre	1.4 %		Crude fibre	1.4 %	1.2-1.5 mm
Ash	8.3 %		Ash	8.1 %	
Total P	1.3 %		Total P	1.3 %	

Initial weight (g)	End weight (g)	Feed size (mm)
0,02	0,1	0,2-0,3
0,1	0,35	0,3-0,5
0,35	1	0,5-0,8
1	2,5	0,8-1,2
2,5	6	1,2-1,5
6	15	1.5

Conclusions

- **Species dependent**
- **Quality ingredients important**
- **Feed composition must follow requirements**
- ***Optimal feed efficiency, matching P/E ratio of the fish***

COPPENS®
Feeds for Aquaculture

Thank you for listening

Introduction to Aquaponics

The Egyptian Case

Presented by Faris Farrag & Ziad Abou El Nasr

Contents

- System overview and advantages
- System design and components
- Water Quality
- Production
- Marketing and Sales

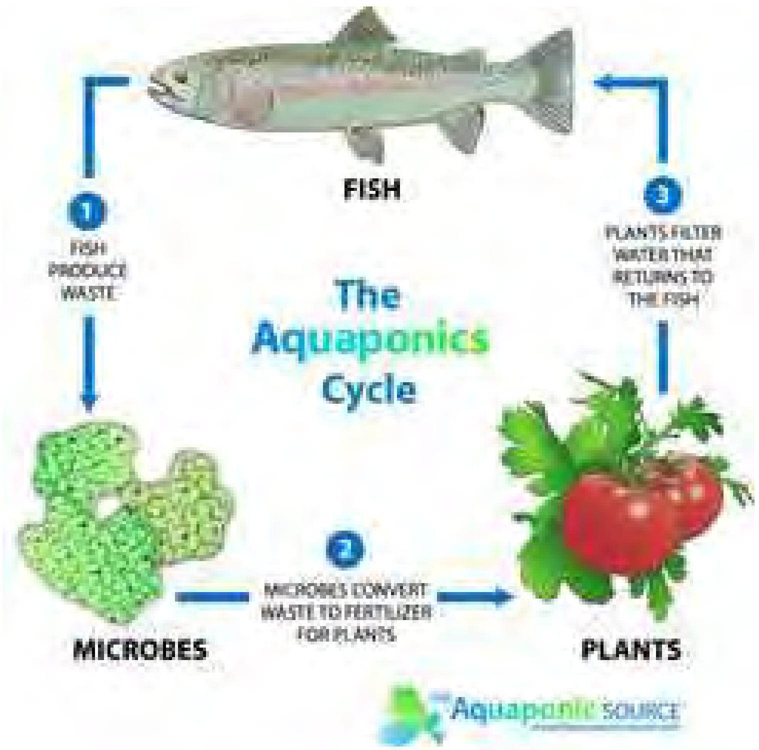
Overview

- Hybrid system that captures and combines the advantages of aquaculture and hydroponics
- Recirculating water system provides extremely efficient water usage with minimal waste
- Tilapia raised in aquaculture component at higher densities, while providing high-quality natural fertilizer for fruits and vegetables grown in hydroponic component
- Higher yielding produce from hydroponics component due to higher planting densities and shorter growing cycles, while acting as a biofilter for increased water quality

Advantages of Aquaponics

- Hydroponic plants extend water use and reduce discharge to environment
- Integrated systems require less water quality monitoring than individual systems
- Profit potential increased due to free nutrients for plants, lower water requirement, elimination of separate biofilter, shared cost of operation and infrastructure
- Can be located close to markets in any environment

Aquaponics Cycle

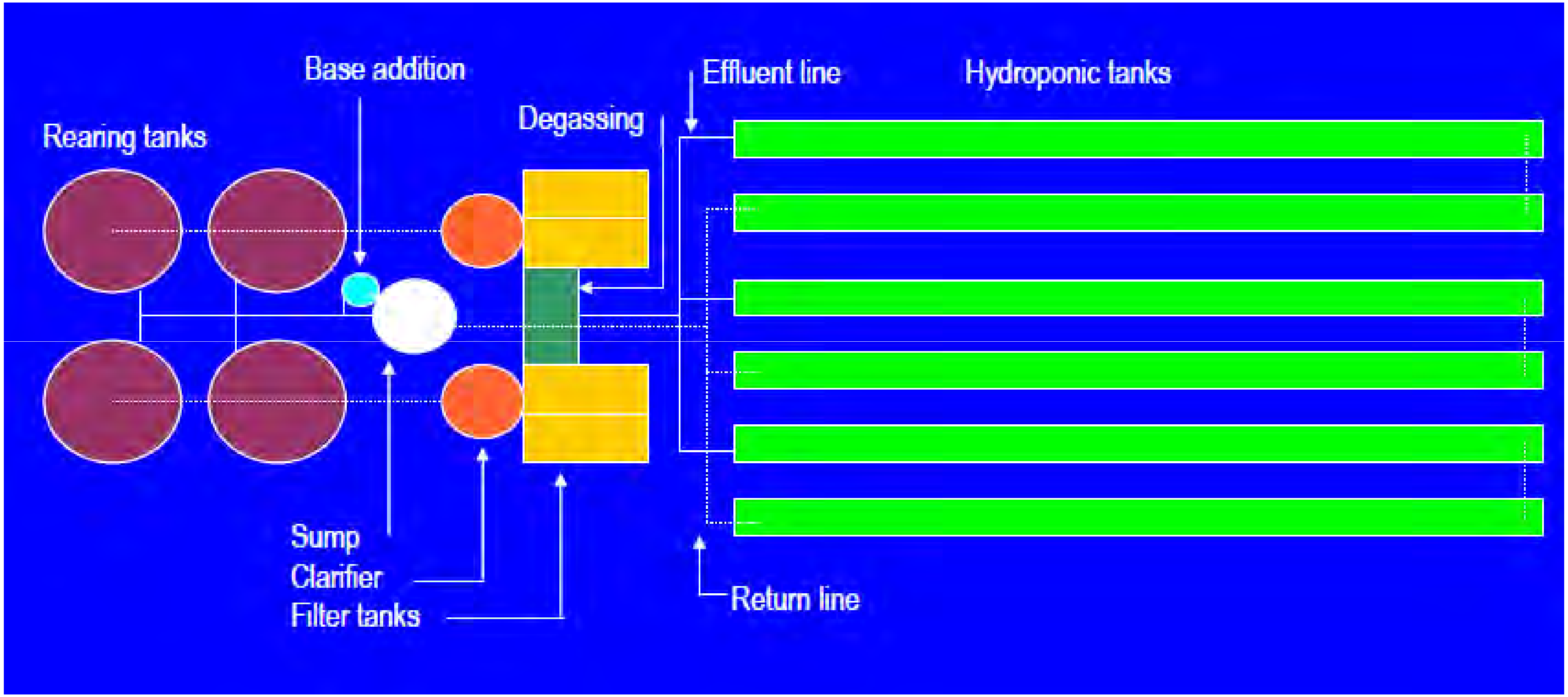


Bacteria make Aquaponics Work

Three groups of bacteria:

- Nitrifying bacteria – Converts ammonia to nitrite to nitrate
- Heterotrophic bacteria – Decompose organic matter to carbon dioxide, water and inorganic minerals
- Denitrifying bacteria – Converts nitrates to nitrogen gas

System Design Layout



Total Water Volume: 110 cubic meters

Land Area: 0.25acres

System Components

- Four fish rearing tanks; 7.8 cubic meters each
- Two cylindro-conical clarifiers; 3.8 cubic meters each
- Four filter tanks; 1 cubic meter each
- One degassing tank; 1 cubic meter
- Six hydroponic beds; 11.3 cubic meters each
  - Total Growing area: 225 squared meters
- One sump tank; 0.6 cubic meters
- Total Water Volume: 110 cubic meters

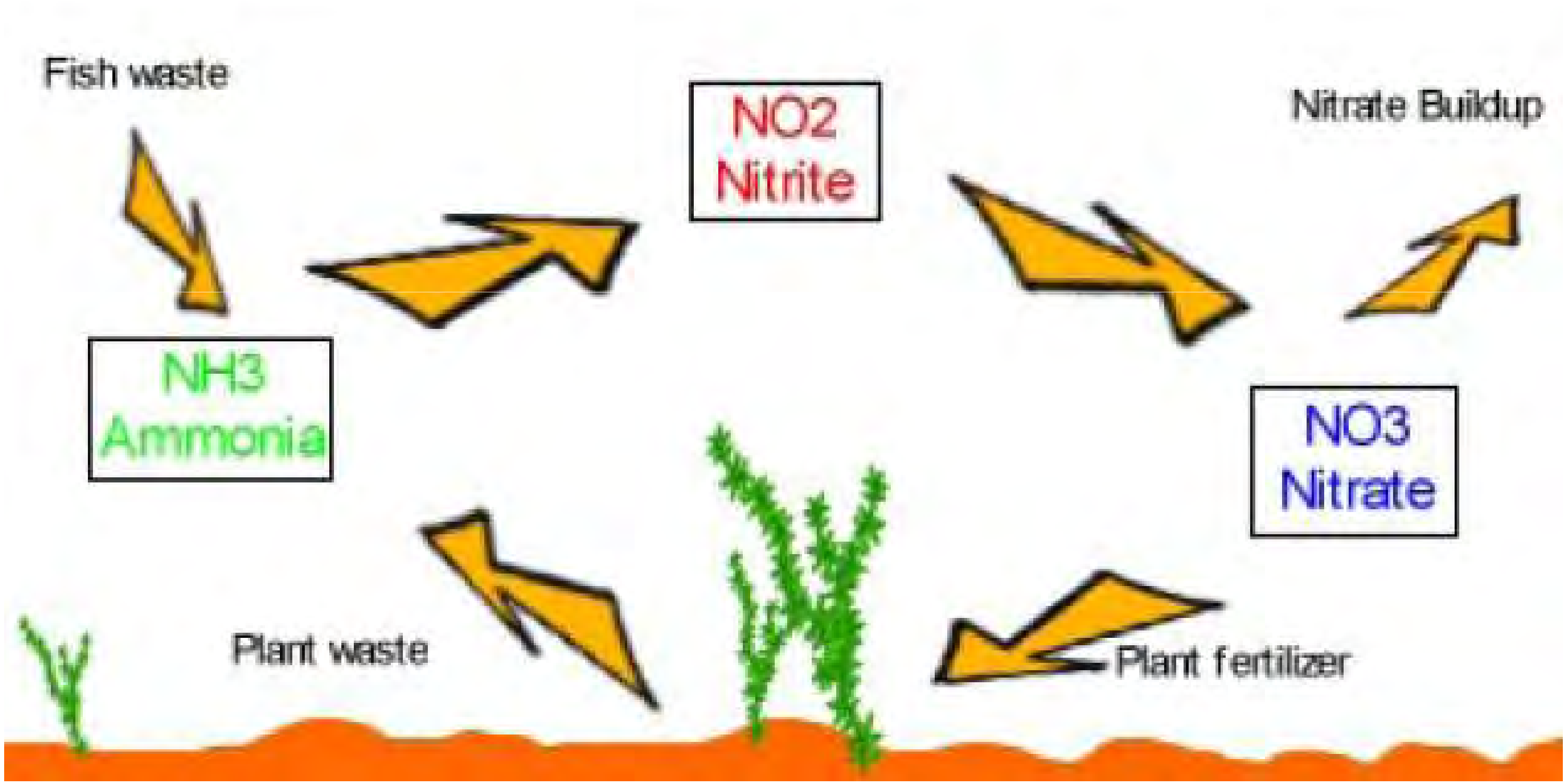
Important Water Quality Parameters

- Dissolved Oxygen (DO)
- Nitrogen (Ammonia, Nitrite, Nitrate)
- pH and Alkalinity
- Carbon Dioxide
- Settleable and suspended solids
- Temperature

Dissolved Oxygen

- Maintain at 5mg/l or higher
- Measure DO frequently in new system, once procedure becomes standard it is seldom measured
- Tilapia will come to the surface for oxygen at 1mg/l
- DO is important for optimal fish, plant and beneficial bacterial growth
- Water holds less oxygen at higher temperatures

Nitrogen Cycle



Biofilteration

- The removal of ammonia and nitrite is referred to as biofilteration
- The combination of plants and raft surface area is the biofilter.

Ammonia Removal

- TAN is removed by nitrifying bacteria (Nitrosomonas) and plants
- Ammonium is oxidized to Nitrite (NO2)
- This process (nitrification) destroys alkalinity and decreases pH
- Nitrifying bacteria grow on surfaces or on suspended organic particles
- Nitrification is optimal at high DO levels and low levels of organic matter

Nitrite Removal

- Nitrite is removed by nitrification bacteria (Nitrobacter)
- Nitrite is oxidized to nitrate (NO3)
- Nitrate is relatively non-toxic
- Nitrite is toxic at 5mg/l
- For Tilapia maintain Nitrite-Nitrogen at 1mg/l

Denitrification

- Under anaerobic conditions denitrifying bacteria convert nitrates to nitrogen gas (N2)
- Denitrification produces alkalinity
- Decreasing nitrates levels is useful when producing fruiting plants such as tomatoes
- High nitrate levels stimulates the growth of leafy green plants

pH

- Most plants prefer pH <6.5
- Nitrifying bacteria perform optimally at pH >7.5
- Compromise and maintain pH at 7.0
- pH should be measured daily
- pH generally declines as a result of nitrification cycle

Water Temperature

- Fish species are temperature dependent
- Tilapia prefer 27-30 degrees Celsius for maximum growth
- Tilapia growth slows drastically under 20 degrees Celsius
- Tilapia die under 10 degrees Celsius
- Incidence of disease increases at lower temperatures as fish are stressed
- Vegetables prefer 21-25 degrees Celsius
- Compromise and maintain around 25 degrees

Production Guiding Principles

- Use stocking rates and planting densities that produce rapid growth and high yields
- Manage fish and plants so that nutrient generation and utilization are consistent and in balance
- Create an excellent environment for both fish and plants
- Do not push system to absolute limit. Instead strive to minimize stress and maximize health of fish, plants and bacteria

Balance in Aquaponic systems

- The correct balance is obtained by feeding at the optimum feeding rate ratio, expressed as grams of feed per squared meter of plant growing area. (g/m2/day)
- The optimum feeding rate ratio in this system design is 60-100g/m2/day.
- Staggered production of both fish and plants evens out the amount of nutrient production and removal

Healthy Growing Conditions

- Fish must be fed at an optimum rate with a complete diet
- Water temperature must be well maintained
- Fish require good water quality which is achieved through good aeration and the removal of ammonia, solids and carbon dioxide
- Overstocking can lead to stress and disease

Pest and Disease Control

- Plant pests and disease require biological control since chemical pesticides will harm the fish and bacteria
- Antibiotics and other treating agents for fish diseases and parasites cannot be used because they could accumulate in the plants

Average Production Yields

- Tilapia - 7 tons annually
- Lettuce – 30000 heads annually
- Basil – 5 tons annually

Marketing Aspects

- Emphasis on superior quality product
- Brand and system education and awareness through multiple channels, particularly at point of sale
  - Offering day visits and tours to various segments (Chefs' day, school trips…)
  - Monthly pop-up restaurants
- Partnership with existing high quality brands to improve distribution and logistics network
- Significant online presence
  - Supports above
  - Developing an online community (Website, blog…) offering advice to like minded community

Local Sales Channels

– Farm Shop
– Farmers Markets
– Gourmet restaurants and supermarkets
– Direct to Consumer weekly produce box delivery
– Partnership with existing high quality brands