Combining recirculation and Bio-flocs technologies: Advantages and potential development.

Yoram Avnimelech
Technion, Haifa, Israel
agyoram@tx.technion.ac.il

Theme of this presentation:

- Different RAS systems are highly developed and enable to produce high fish biomass using limited space and water resources.
- However, These are rich men toys.
- It is badly needed to develop low cost systems that can help to produce high fish biomass in a sustainable and consistent way.

Capture Fisheries and Ac

+ China

Finfish, crustac., molluscs	2001 million	2001 (%)
Total Production	128.8	100
Inland Production	31.2	24
Marine Production	97.6	76
Total Capture Fisheries	91.3	71
Total Aquaculture	37.5	29
Inland Aquaculture	22.4	17
Marine Aquaculture	15.1	12
Human Use	99.4	77
Non human use	29.4	23
World Population (Billion)	6.1	
Per capita food fish supply (kg/person)	16.3	

Expected (needed) Aquaculture Production

Year	1963	1993	2003	2010	2025	2050
Million MT	1.76	17.8	41.9	61	120	210
Source	FAO	FAO	FAO	Wijkstrom 2003	New 1991	Wijkstrom 2003

Within 20 years Aquaculture production has to be ~ 3 folds than now

Within 45 years, 4-5 folds


How can we do it???
What are the major limitations?

1. WATER

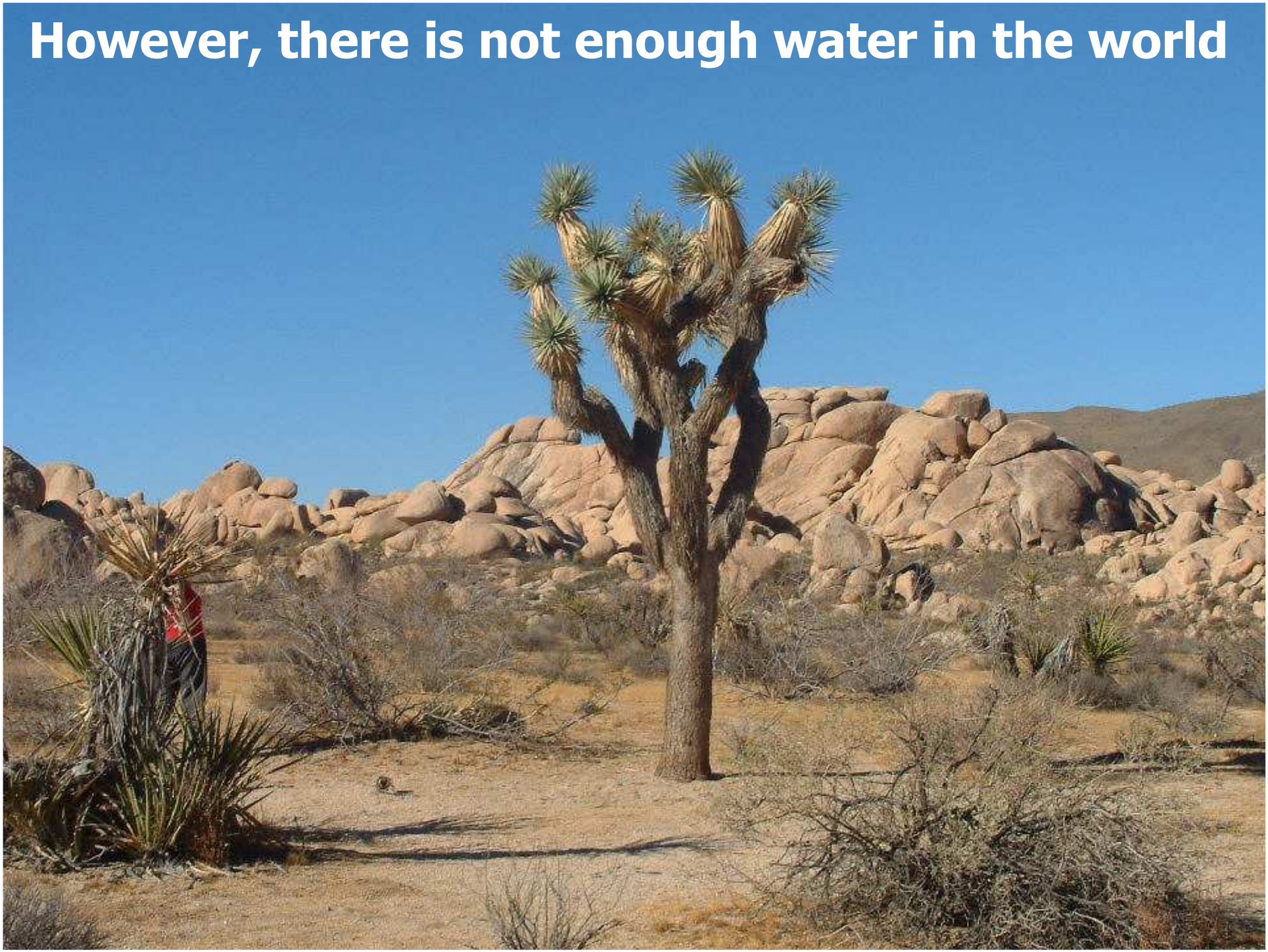
- **Traditional aquaculture production, ca 2000 kg/ha*yr**

Water loss (evaporation + seepage, NOT including drainage) ~ 35,000 m3/ha*yr

For present average annual per capita fish consumption, 18 kg, we need 315 m3 water per capita.

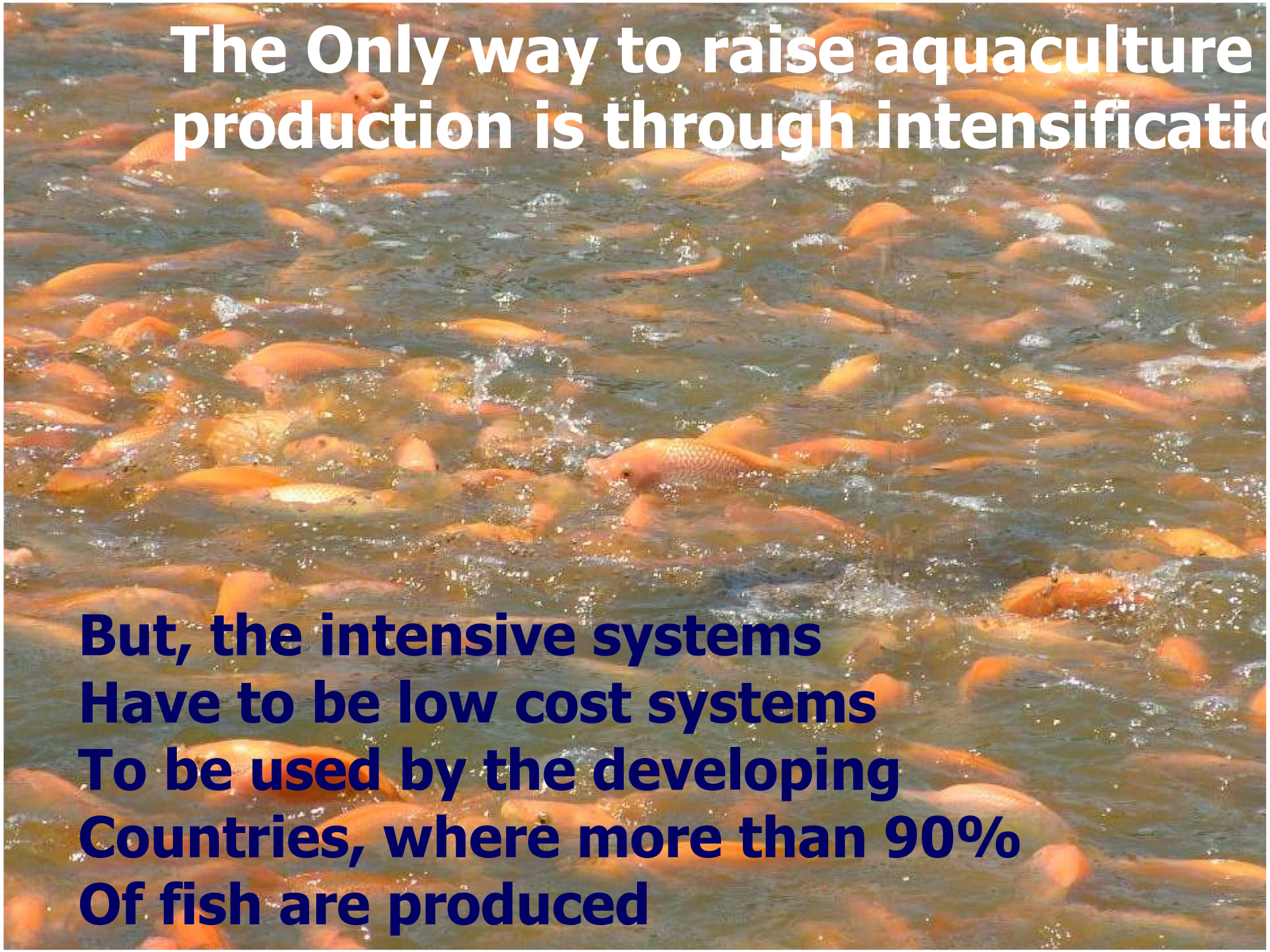
For recommended (FAO) future consumption of 25 kg, we will need 438 m3 per capita

However, there is not enough water in the world



2. LAND

- **Conventional aquaculture takes 50 sq.m per 1 kg fish.**
- **Per capita the land required is 900 sq.m/capita for present consumption and 1250 sq.m/capita for future consumption.**
- **Land required is flat, close to water sources, rivers or sea. Such land is required for urban development, agriculture, tourism and nature protection.**
- **Finding additional suitable land for ponds, especially near the sea, is next to impossible.**


The Only way to raise aquaculture
production is through intensificatio
But, the intensive systems
Have to be low cost systems
To be used by the developing
Countries, where more than 90%
Of fish are produced


The 3d issue is feed:
1.Environmental concerns of feed sources
2.Cost of feed

Fish Protein and Fish Oil Use

Farmed Fish	*wild fish requirements / kg farmed fish*
Marine finfish	5
Eel	4
Salmon	3
Carps/Catfish a.o.	<1

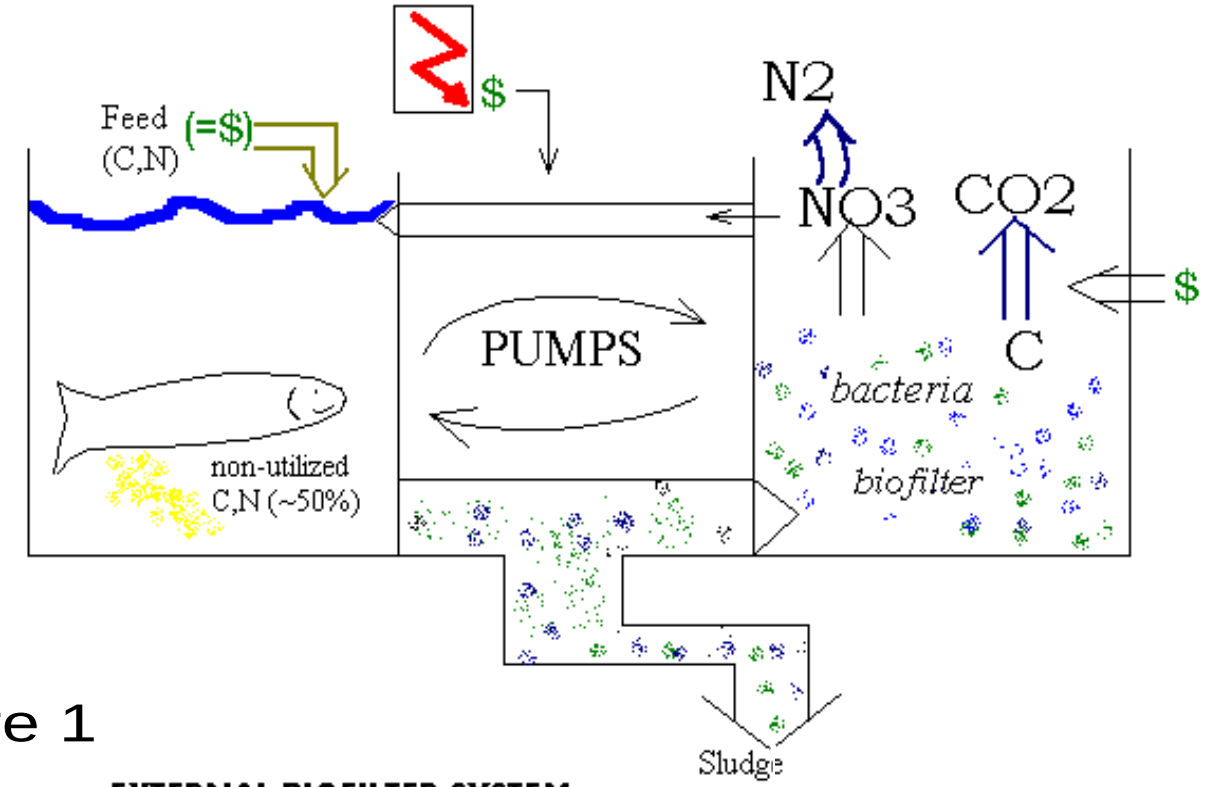


Figure 1

EXTERNAL BIOFILTER SYSTEM

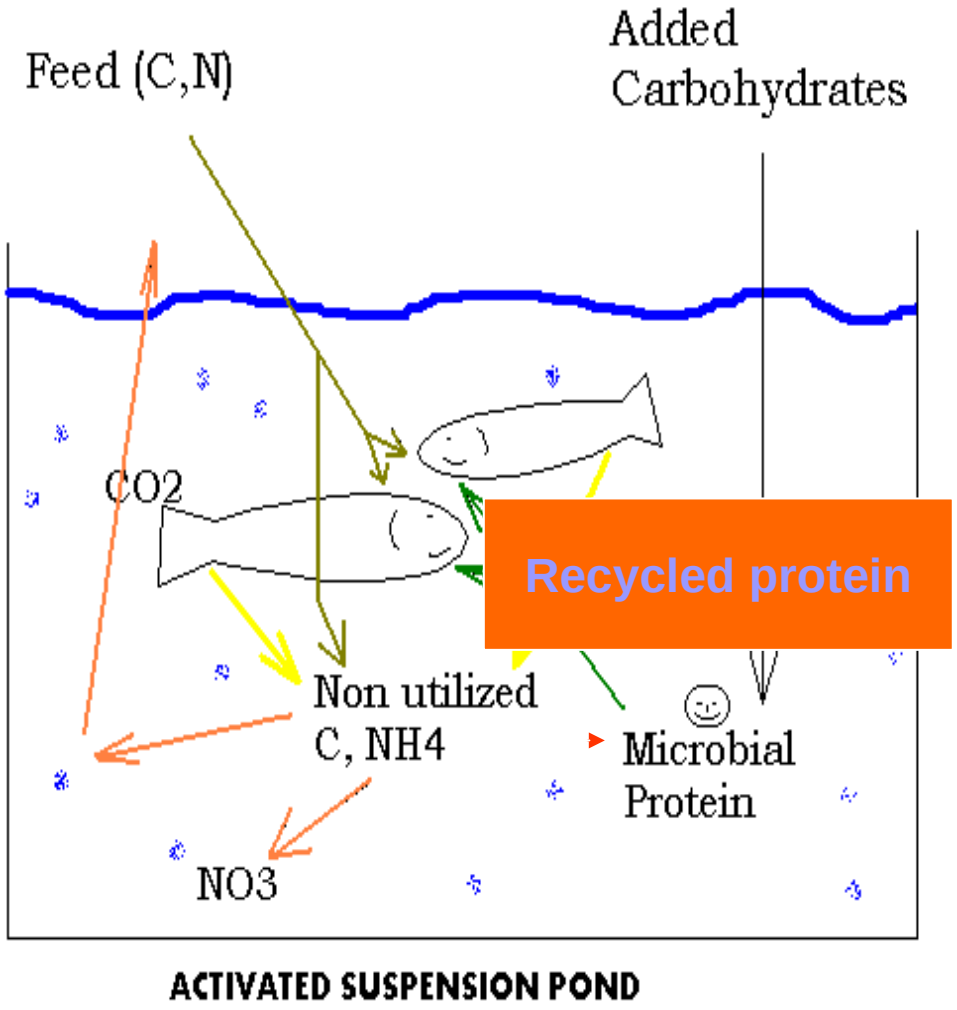

Feed (C,N)
Added
Carbohydrates
CO2
Recycled protein
Non utilized
C, NH4
Microbial
Protein
NO3
ACTIVATED SUSPENSION POND

Figure 2

Data on feed protein utilization

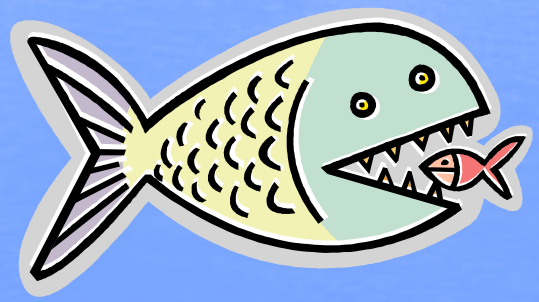
- **Conventional fish, shrimp ponds 20-25%**
- **ASP Tilapia ponds (Avnimelech) 45%**
- **ASP Shrimp ponds (McIntosh) 45%**
- **Closed shrimp tanks (Velasco) 63%**

- **ASP shrimp ponds, ^{15}N study**
  18-29% of total N consumption

Michele Burford et al.

Better overall feed utilization

- **In closed systems, fish consume residues.**
- **It was found, (Panjaitan 2004) that shrimp growing in bio floc tanks, had the same growth rate with 70% of feed as compared to flow through tanks**




Can the two approaches be combined??

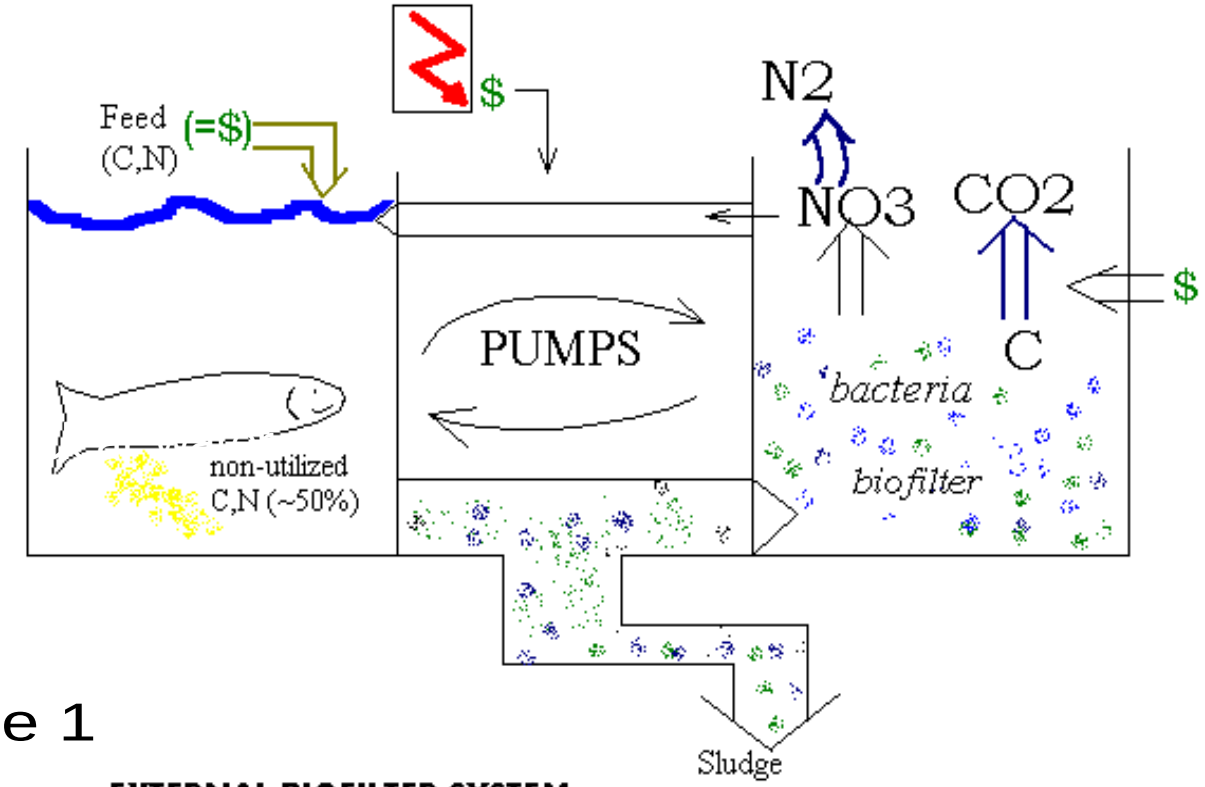


Figure 1

EXTERNAL BIOFILTER SYSTEM

What is the optimal (maximal) turbidity of the water? i.e. What should be the suspension residence time?? The higher turbidity & residence time, the higher will Feed utilization

IT CAN BE DONE

- **Technically, it is easy to adjust water exchange rate and control TSS and SRT. It can be even automated.**
- **The same system can be adjusted for a variety of fish species, densities and production stages**

2. The Wageningen approach

- **Oliver Schneider and co-workers suggested to reuse the sludge following fermentation and microbial protein bio-synthesis in an external system.**
- **One advantage, a more efficient oxygen supply.**

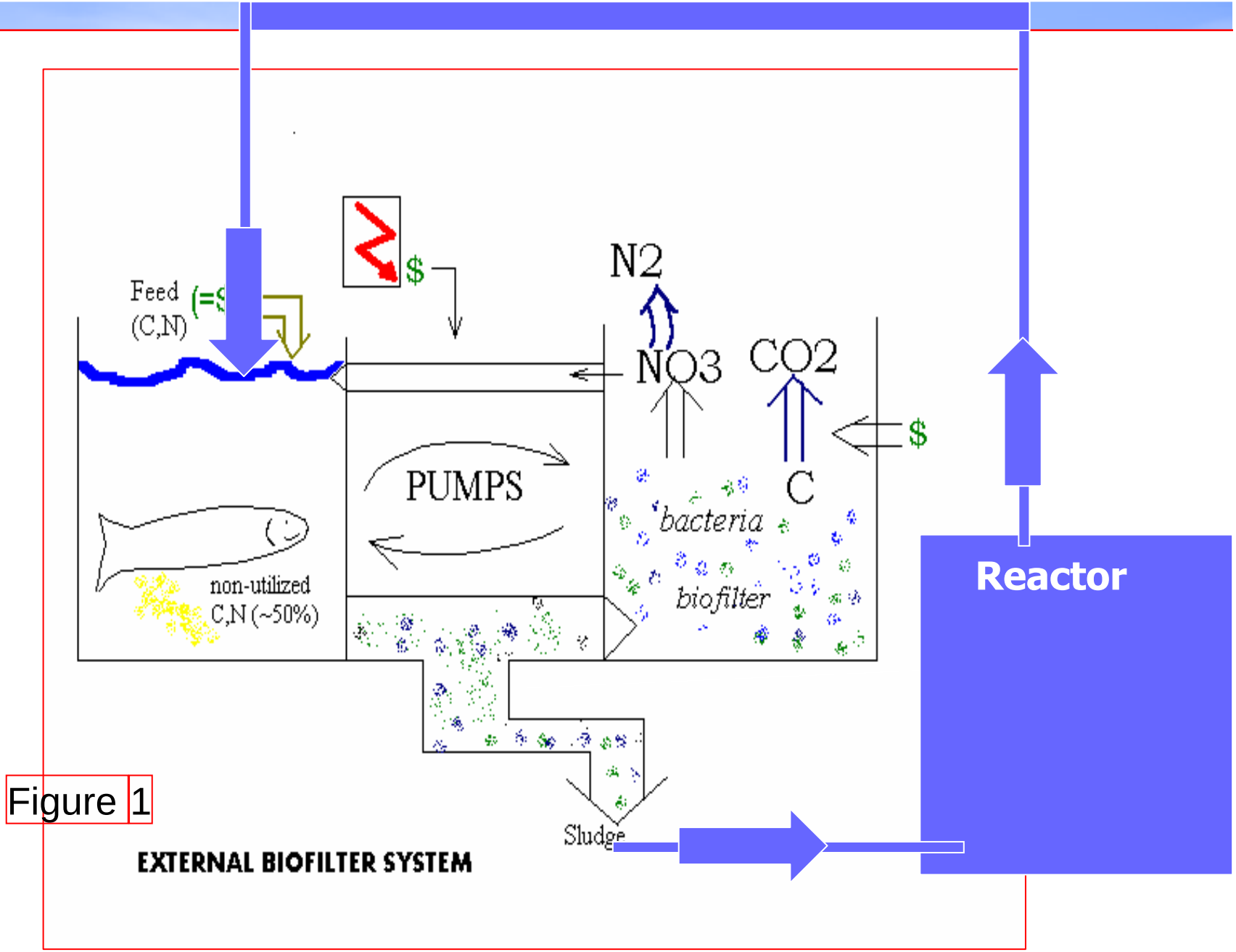
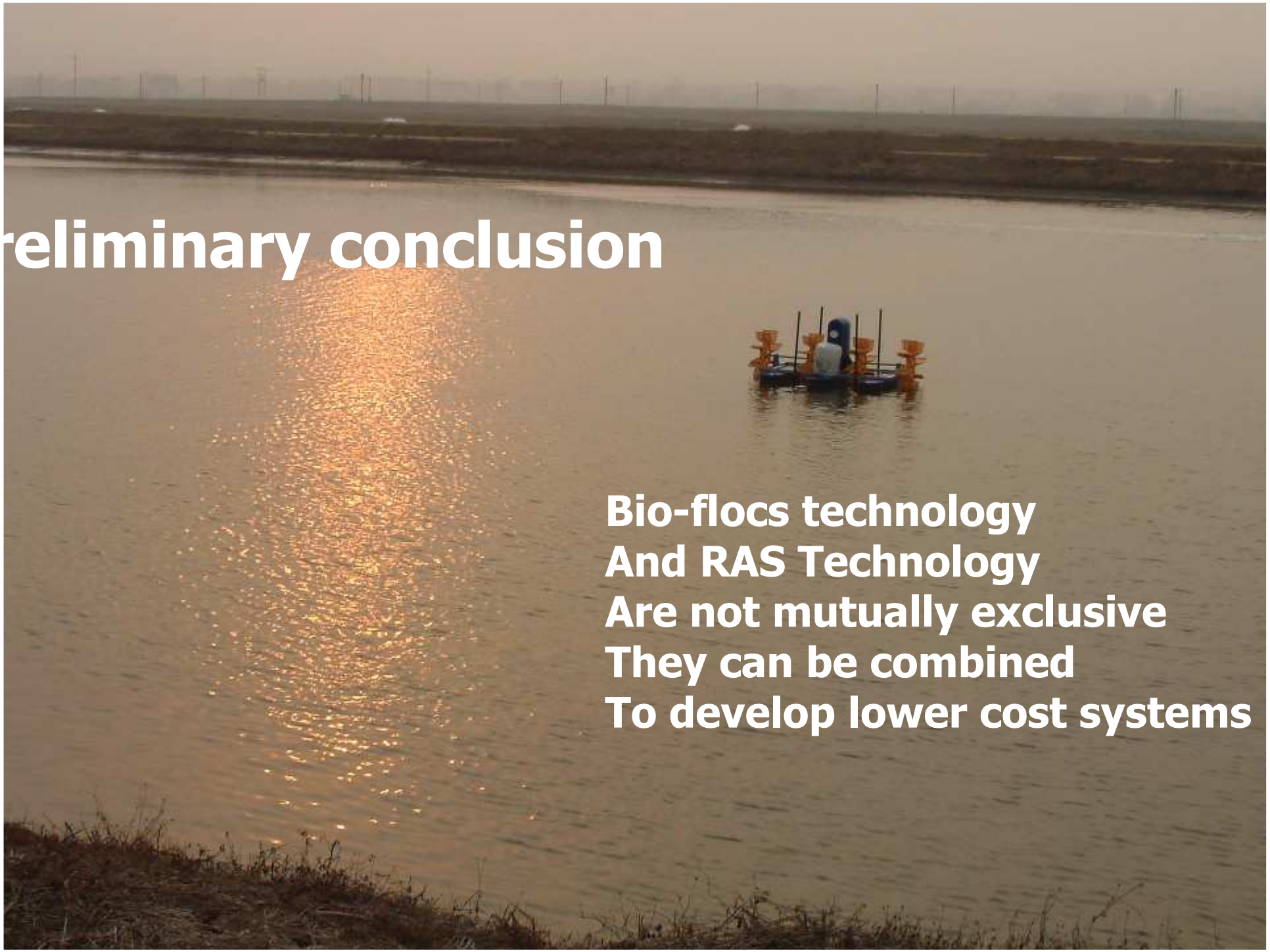
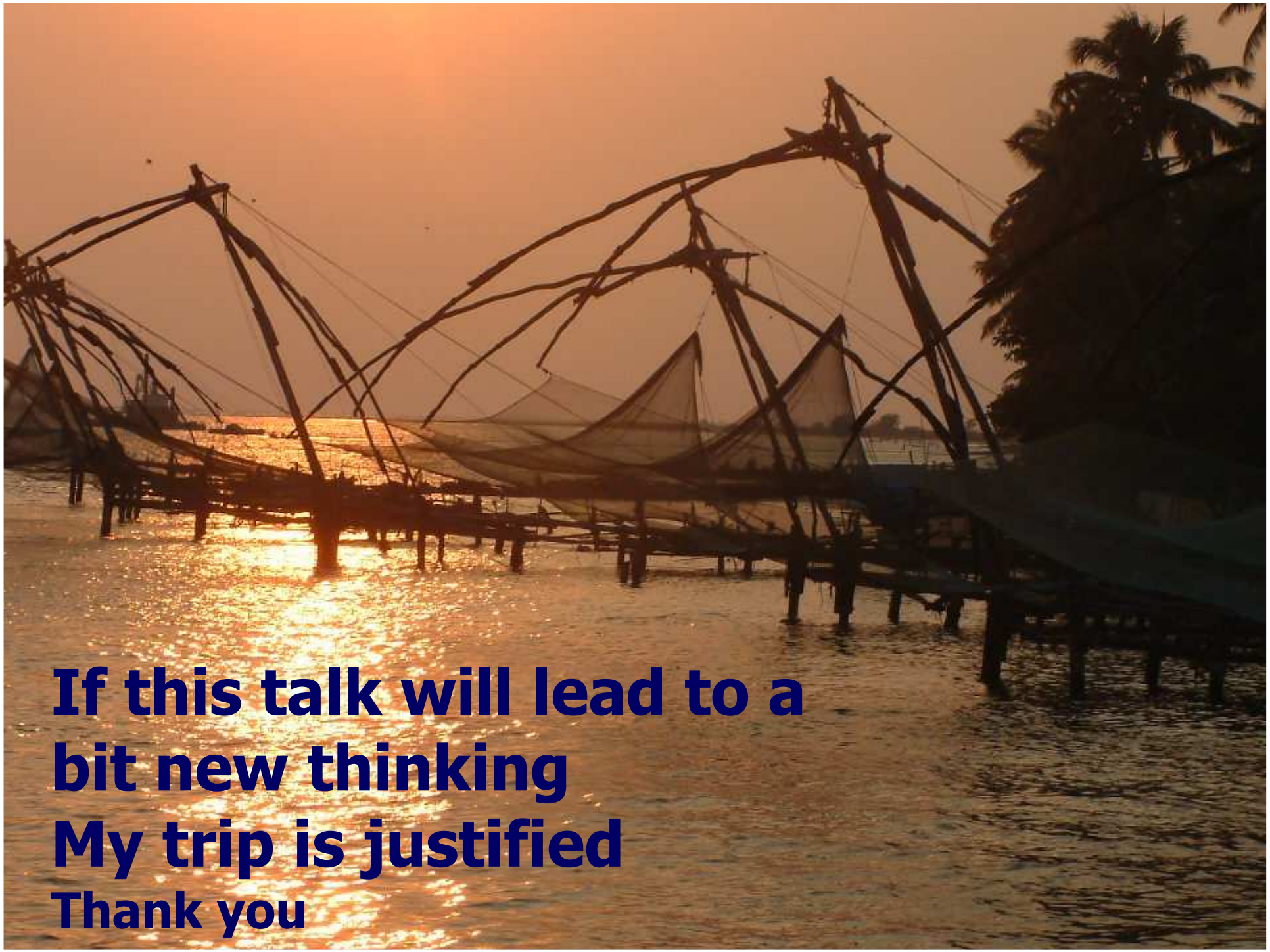

Feed
(C,N)
$
N2
NO3
CO2
$
C
PUMPS
bacteria
biofilter
non-utilized
C,N (~50%)
Sludge
Reactor
EXTERNAL BIOFILTER SYSTEM

Figure 1


reliminary conclusion
Bio-flocs technology
And RAS Technology
Are not mutually exclusive
They can be combined
To develop lower cost systems


If this talk will lead to a
bit new thinking
My trip is justified
Thank you