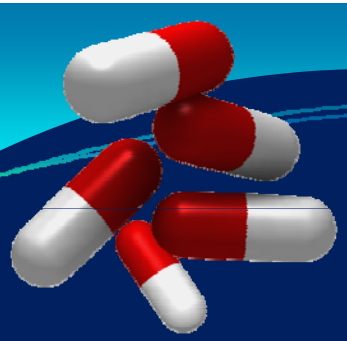
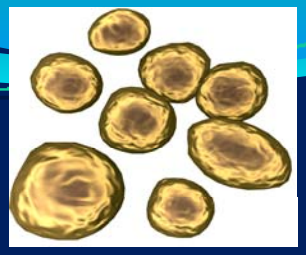
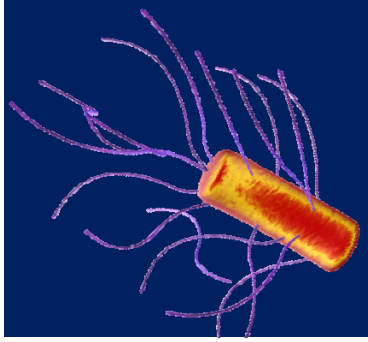
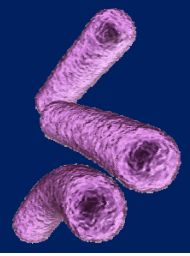




MONITORING OF ANTIBIOTIC RESIDUES AND RESISTANT BACTERIA IN WASTE GENERATED FROM AQUACULTURE

MANAS KUMAR SINHA

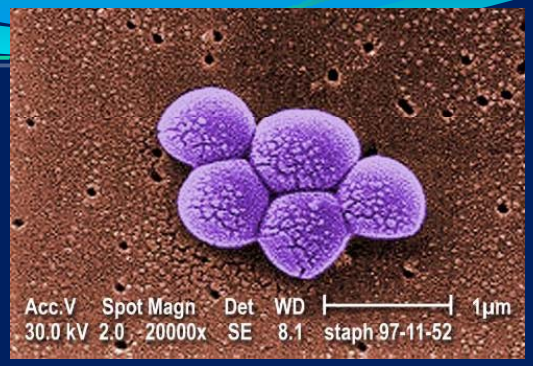



INTRODUCTION :

Antibiotic resistance is a global problem of increasing significance that takes a costly toll on lives and the health-care economy around the world.

Highly mobile populations, the ease of ever-growing international travel and trade, high density populations, the growth of aquaculture industry, environmental changes, continuous pathogen evolution, and increasingly complex prophylactic treatments have all increased the potential for the emergence and rapid dissemination of new or variant forms of known pathogens, and present an array of new challenges to aqua culturists, environmentalists, microbiologists and Public health officials.

WHY IMPORTANT???



Surveillance and monitoring of antibiotic resistant bacteria is essential for detecting and controlling outbreaks, identifying populations most at risk, designing and evaluating intervention strategies, and focusing the use of scarce resources so that they can be used most efficiently and effectively to prevent illness and save lives.

Aquaculture

- Fast growing food sector
- 90% of global production in Asia
- Reduce gap between supply and demand
- Livelihood for small scale-farmers
- Huge Contribution to the economics of many countries

Food safety issues

- Risk of contamination greater in fresh water and coastal ecosystems than open sea.
- Hazards-food borne infections, pathogenic bacteria, residues of agro chemicals, veterinary drugs and heavy metal contaminations
- Inappropriate aquacultural practices

Food safety issues

- WHO reported worldwide consumption of raw or inadequately processed has risks
- Fish ponds are habitat of pathogenic organisms originating from human and animal excreta and use of fertilizers
- WHO with FAO and NACA devoted to food safety issues in Aquaculture
- In 1995 FAO adopted code of conduct for responsible fisheries for food safety
- Responsible production level addresses safe and effective use of inputs

Traceability

- Used more as a marketing tool than point of quality and safety
- Consumers want assurance on safety of eating, welfare conditions of farm and way of fish reared
- No single quality assurance system worldwide
- . Own transparent standards &guidelines in individual countries

Traceability

- The marine stewardship council, a global authority works on sustainability & traceability
- MSC meets high benchmarks for certification &eco-labeling programmes including FAO guidelines &ISEAL Code of good practices
- Its certification process -not traceable and food safety not assured
- Food processing industry should follow strict safety regulations under HACCP.but processing practices according to the retailer or food service outlets
- Some countries setting seafood inspection & control procedures for traceability measures& audited assurance systems

INDIAN PERSPECTIVE….

- Creation of functional entities
- Formalizing Legal requisites (National registrations)
- Development of SOP (Standard Operating Procedure)
- Development of Traceability system
- Operation of Aqua Society (implementation of SOP , BMP and Traceability system)

Legal

- Farms may not be formally registered
- Operations / Procedural
- Efficiency in adopting BMPs (especially Bio-security)
- Traceability
- Food safety
- Recording keeping

WHY MONITORING????

Monitoring can serve a number of purposes in combating antibiotic resistance.

- Serves as an early warning system for the emergence and spread of new forms of resistance.
- Provides valuable information about geographic variations in incidence and prevalence of resistant pathogens and identify populations at risk.
- Vital for developing public health interventions (Food Safty)
- Prioritizing resistance problems.

WE NEED…….

- Surveillance data
- Laboratories and reliable testing methods.
- Collection of isolates should be appropriately representative for the purposes of the surveillance activity.
- Reporting

HOW IT SHOULD BE???

- Simple
- Flexible
- Acceptable to both the producers and consumers

WHAT IS TO BE DONE??

- THOUROUGH RESEARCH ON RAPID RESIDUE DECTECTION
- IDENTIFYING CORE PARTNERS (MOA&FW, ICAR RESEARCH INSTTUTIONS, STATE FISHERIES DEPTS, CENTRAL GOVT ORGANISATIONS LIKE CAA, NFDB,MPEDA ETC, INSTITUTIONS AND UNIVERSITIES, NGOs)
- STRICT LEGISLATIONS
- STANDARDIZATION OF THE INPUTS
- REGISTERING AQUA EXPERTS

PROBABLE IMPACTS OF SHRIMP FARMING

ENVIRONMENTAL

LAND

LAND-USE
SALINISATION
FLOODING
EROSION

WATER

EUTROPHICATION
SOURCE WATER QUALITY

BIOLOGICAL

BIO-DIVERSITY
WILD SEED
SPAWNERS
DISEASES

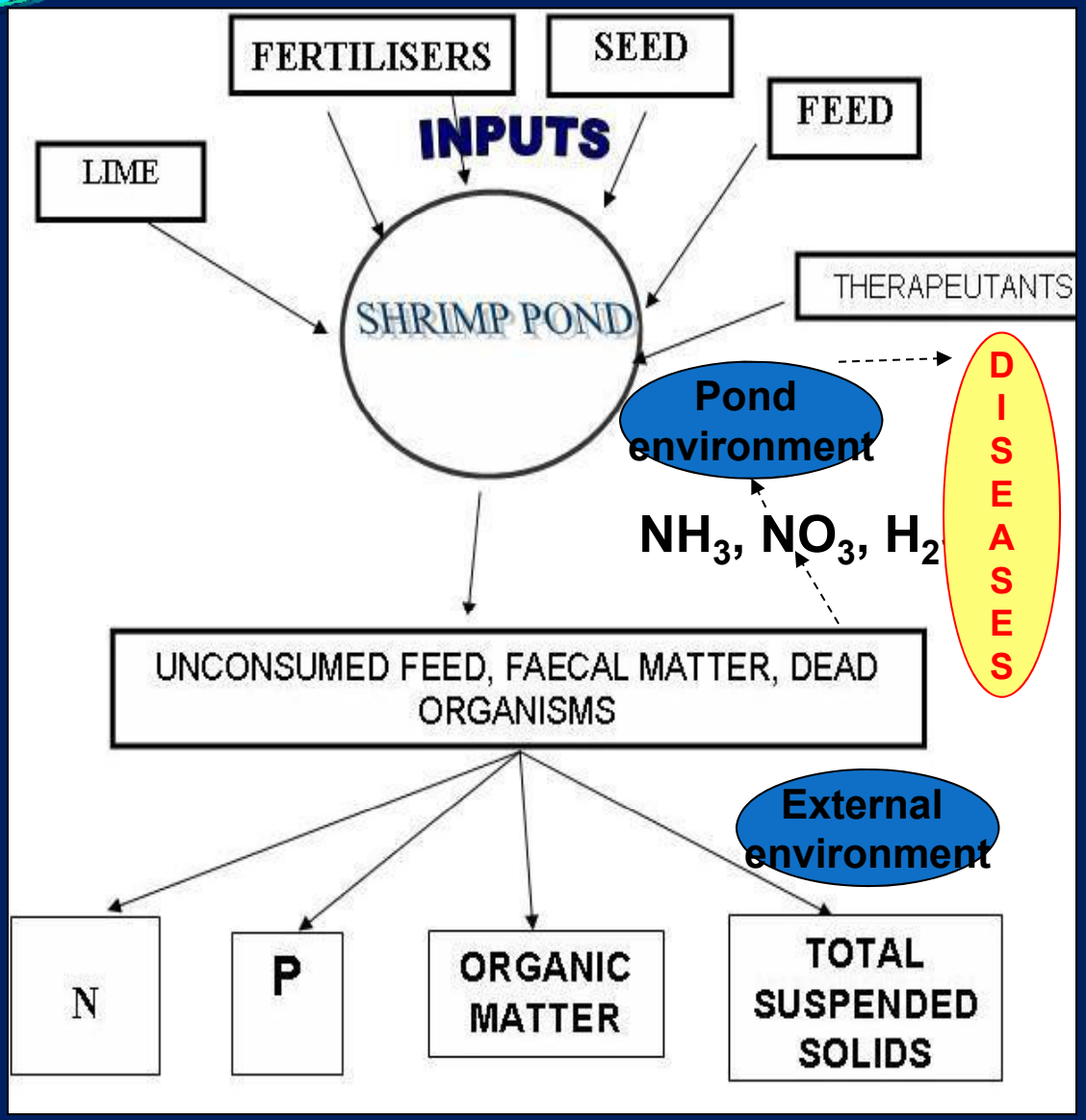
SOCIAL

ACCESS
HEALTH

ECONOMICAL

STANDARD OF LIVING
EMPLOYMENT

Inputs and output waste in shrimp pond



More impact due to -------

- Concentration of farms in area
- Unregulated development of shrimp farms
- Types of culture systems
- Large volume of discharged water
- Poor flushing capacity
- Self pollution

Facts from literature

- Shrimp farm discharge is
  - ❑ High in volume
  - ❑ Turbid with suspended solids and
  - ❑ Rich in particulate and dissolved organic matter and nutrients (N and P).

- The intensity of the discharges depends on the technology and management practices (stocking density, quantity of fertilizers, un-consumed food and metabolism of nutrients, etc).
- Highest quantity and poorest quality of discharge water was found just before harvest time.
- Concentrations of nutrients and solids were significantly higher during harvest especially the final 20 cm of discharge and the greatest increase occurred during the final 5 cm of discharge (comprising over 75% of the total load).

- Discharge water during regular flushing and at harvest can account for 45% of nitrogen and 22% of organic matter output in intensive ponds.
- The shrimp pond water quality tends to deteriorate through the grow-out period, as feeding rate increases with shrimp size and biomass.

Effluent from shrimp Culture

Self pollution with in the system

Hyper nutrification and eutrophication as a result of shrimp culture,

Such impacts have not been quantified.

Quality of wastewater from different systems of shrimp farming

Parameters	India		
	Extensive	Semi-intensive	Intensive
Phosphate – P (mg/l)	0.05	0.12	0.11
Nitrate- N (mg/l)	0.15	0.04	0.22
NH_3 - N	0.007	0.02	0.013
Hydrogen sulphide (mg/l)	0.02	BDL*	BDL*
COD (mg/l)	31.00	22.8	30.30

Comparison of discharge water from shrimp farms with effluent water quality from few industries

Parameter*	Discharge water from shrimp farms	Effluent water quality from Industries in India				
		Tannery[1]	Distilled[2]	Sugar[3]	Paper[4]	Rubber[5]
pH	7.0-8.2	7.8	5.2	7.9	8.6	7.7
DO	2.1-5.0	Nil	Nil	Nil	1.9	2.3
TSS	20.0-96	1688	1810	1666	-	134
Alkalinity	97-140	-	3959	1650	764	218
BOD_5	9.0-48.0	1335	8420	735	115	-
COD	16.4-73.6	5125	-	-	171	326
NH_3-N	0.009-0.226	-	2.0	2.5	-	14.6
TN	0.80-1.9	-	5.4	3.5	-	-

*All Parameters are in ppm, except pH

Superscript 1- Mariappan, 1994; 2&3- David & Ray, 1996; 4 - Ray *et al*, 1979; 5- Ghosh *et al*, 1979.

Facts from of farmer's Perceptive

- Post culture discharge water management → not practiced in most farms ⟶ not seen to directly affect production and also due to additional cost.
- The regulations will be unnecessarily restrictive and expensive.
- Presently, most of the farms lack DWTS .
- The farms which do have DWTS facility also do not conform to the guidelines issued by Coastal Aquaculture Authority (CAA).

Legal obligation

Coastal Aquaculture Authority (CAA)

- *Penaeus monodon* – Stocking density (SD) upto 6-10 no/ m^2 is permitted and DWTS is mandatory for farms of 5 ha and above.
- *Litopenaeus vannamei* - SD upto 60 no./m^2 and the DWTS has become mandatory for all the farms culturing *L. vannamei* irrespective of their size.
- The size of the DWTS should be more than the size of the largest pond in the farm.
- Harvesting should be sequential depending on the size of the DWTS.
- The quality of the waste water should conform to the standards prescribed under the Guidelines issued by CAA.
- Outbreak of disease - the water should be chlorinated and de-chlorinated before release into source water.

Guidelines/ standards for discharge water from coastal aquaculture farms in India and Thailand

Parameters	India Final Discharge Point		Thailand
	Coastal Marine Waters	Creeks/estuaries- when the same inland water course are used as water source and disposal point	
pH	6.0-8.5	6.0-8.5	7.0-8.7
Suspended Solids mg/I	100	100	100
Dissolved Oxygen mg/I	Not less than 3.0	0.5	1.8 – 2.9
Free Ammonia (as NH_3 – N) mg/l	1.0	0.5	1.8 – 2.9
Bio-chemical Oxygen Demand (BOD) (5 days at 20°C) mg/l	50	20	10
Chemical Oxygen Demand (COD) mg/l	100	75	-
Dissolved Phosphate (as P) mg/l	0.4	0.2	0.4
Total Nitrogen	2.0	2.0	4.0

Waste water consists of:

Solid matter (uneaten food, faecal matter, plankton etc.)
Dissolved matter (Metabolites, N, P and other chemicals, drugs and antibiotics etc.)

Effect of effluent in receiving water bodies:

Discharge water has different characters than the receiving water. The receiving water can assimilate pollutants through various processes.

Physical:
Turbidity
Sedimentation
Salinisation

Biological:
Eutriphication
Low Oxygen
BOD and COD

Chemical:
Drugs
Antibiotics
Pesticides
Heavy metals

The final goal of the DWTS is

- Workable model with minimum area and minimum pumping requirement (cost effective)
- Revenue possibility
- Can be imposed by Regulatory bodies.

- Evaluation of effectiveness of DWTS under field conditions and its demonstration.

Treatment of pond effluent:

Treatment system should be of low cost but effective methods are available in several temperate countries to reduce load of BOD suspended solids and N and P. Chemical methods are generally ineffective and should be avoided.

Physical and biological methods are to be advocated for this purpose. Nutrient and organic matter concentration in effluents is highest during harvesting time and subsequent cleaning of ponds.

Aeration ponds

Helps (+) DO and oxidation of any left over NH_3 and Organic matter.

Water quality monitoring programme:

Important water quality variables should be measured which are most likely to cause deterioration of water quality conditions.

Location, frequency and time of sampling:

Sampling stations	**-**	**Intake and out fall point**
Sampling schedule	**-**	**Weekly depending upon the nature of work and other factors**
Sampling time	**-**	**Morning and all formalities should be completed by evening**

Effluent regulation:

All the aquaculture farms shall treat the effluents to the relevant standard specified for the final discharge points of the effluents.

Management of waste water of shrimp farms

Shrimp farm waste water is the most significant of all the factors that contributes to the degradation of environment causing self pollution in the system due to intensification of technology. The terms most often used are:

Farm discharge water
Farm waste water - Farming operation

Farm effluent water - Processing Industry

↓

Receiving waters
(creeks, back waters, canals, estuaries and sea)

Causes of water pollution

i) Concentration of farms in area
(ii) Unregulated development of shrimp farms
(iii) Large volume of discharged water
(iv) Limited water supply
(v) Poor flushing capacity
(vi) Types of culture systems

Traditional extensive and modified extensive	-	80%
Semi intensive	-	15%
Intensive	-	5%

Existing culture ponds

- Removal of waste by draining and drying of the pond bottom after the production cycle are some of the steps to be followed for keeping the pond environment clean.

Draining and removal of black soil

- Draining the pond bottom water after the harvest of previous crop
- Scraping and removal of black soil and disposal of it at safe place
- Application of bleaching powder to sterilise the pond bottom

Recently drained pond bottom

Improperly drained pond bottom

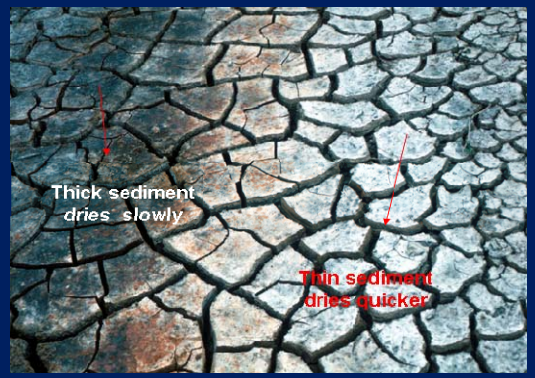
Scraping and removal of black soil

Drying

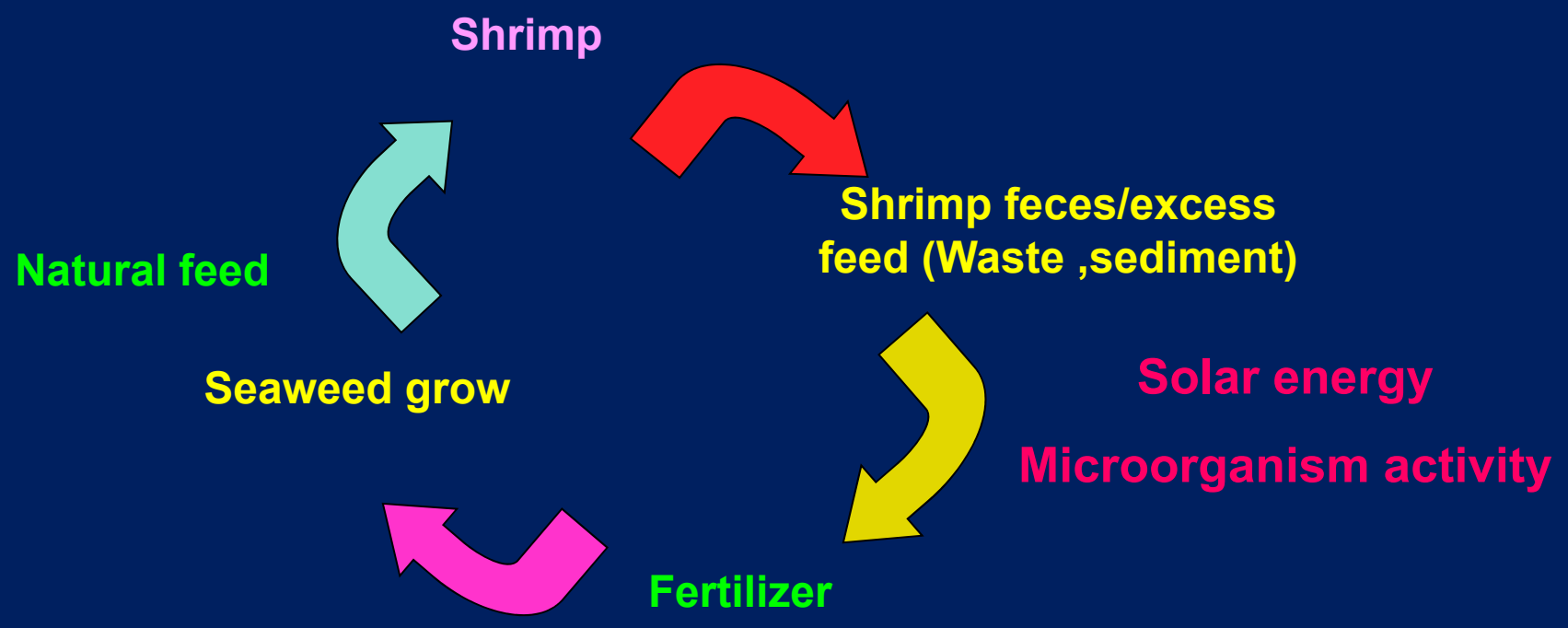
- Drying is an effective method for elimination and control of undesirable species in the pond.
- After harvesting of previous crop the pond bottom is allowed to dry and crack, primarily to oxidize the organic components left after the previous culture and also for the mineralization of nutrients.
- The optimum moisture content for drying is 20%, but it might vary among soils from different ponds.

Properly dried pond bottom soil

Unevenly dried pond bottom soil



Utilize of waste and sediment as natural Fertilizer and feed for microorganism



SUMMING UP……FOR MONITORING

- LOOKING FOR A REGULATORY BODY-CAA CAN BE EXPANDED
- PRODUCT REGULATION –GUIDELINES AND STANDARDS
- ADVISORY TO FARMERS- WORKSHOPS/SEMINARS/PAMPHLETS
- FORMATION OF SOCIETIES/AQUA CLUBS
- REGULATE THE SOURCE-WATER/SOIL/SEED/FEED/OTHER INPUTS
- STUDY ON RESIDUE OF ANTIBIOTIC IN MEAT AFTER PRESERVATION.

LOOKING FORWARD.....