ECOLOGICAL ENGINEERING

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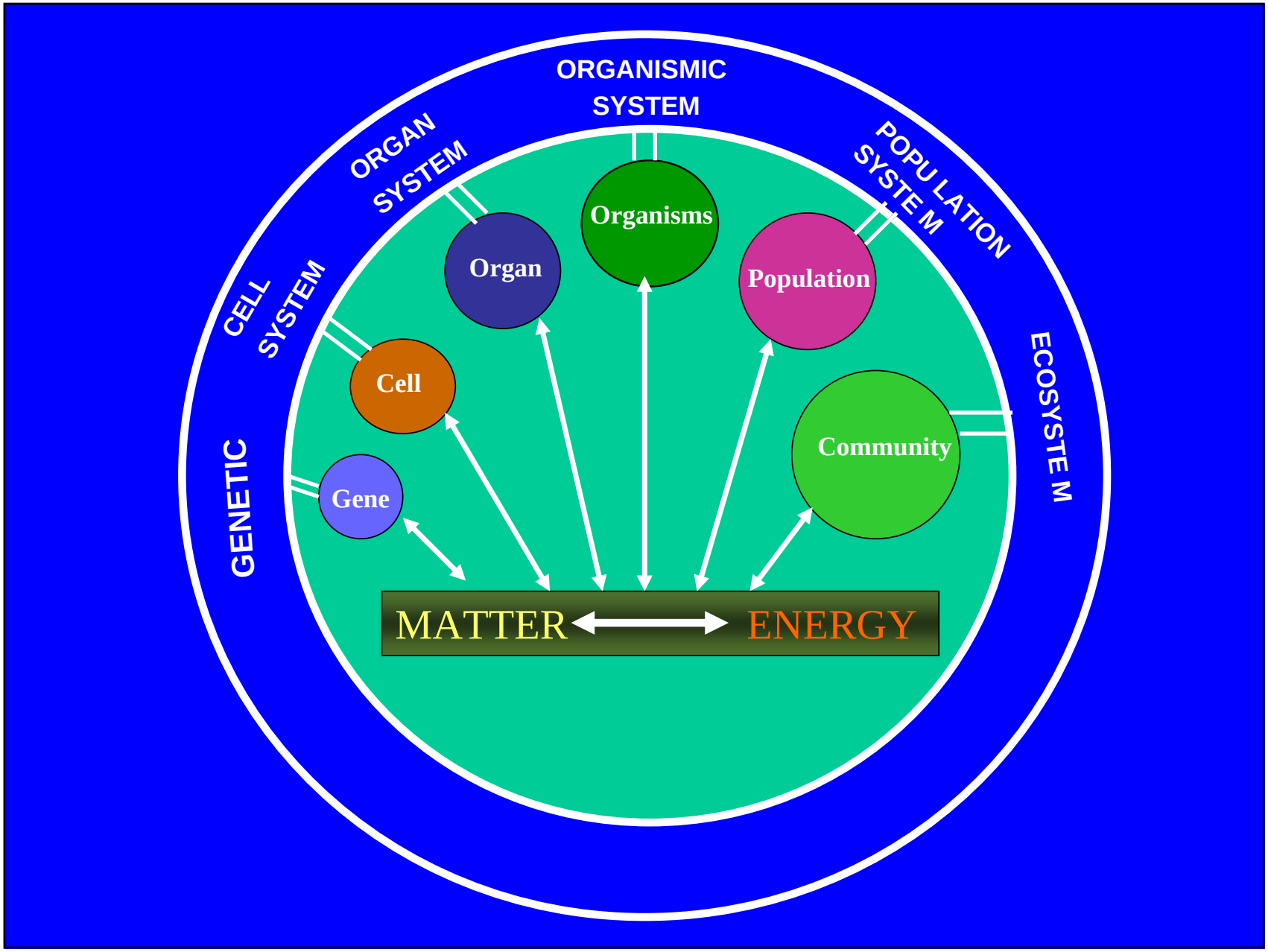
Major problems of Environmentally Sustainable Future

- Population Explosion
- Rapid pace of Industrialization
- Substantial rise of Urban Population
- Small population of India is served by sewers
- Sewerage system exists only in few largest Cities
- Uncontrolled spillage of Wastewater
- Acute crisis of water and clean water

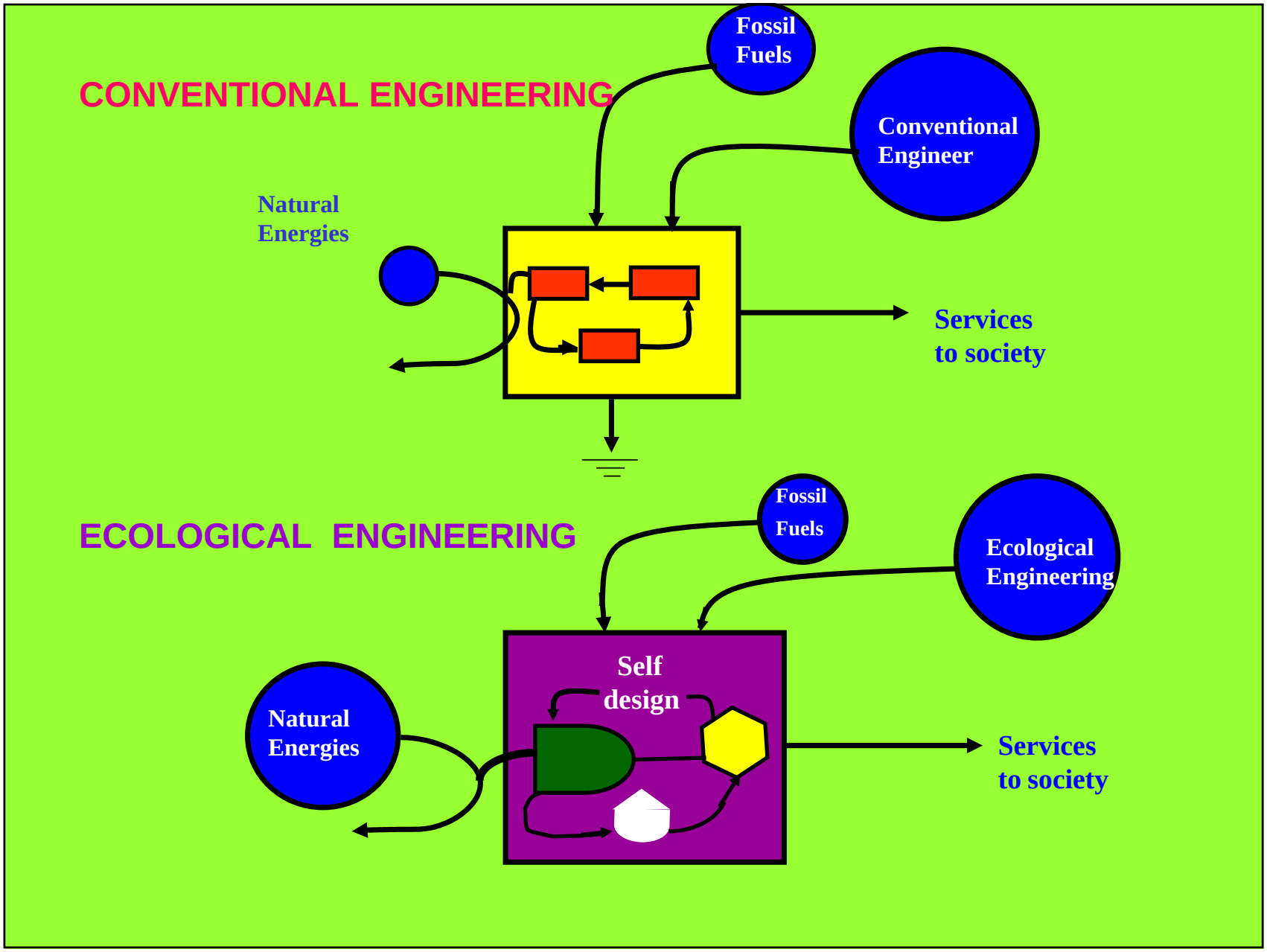

ORGANISMIC SYSTEM
ORGAN SYSTEM
POPU LATION SYSTE M
CELL SYSTEM
ECOSYSTE M
GENETIC
Organisms
Organ
Population
Cell
Community
Gene
MATTER
ENERGY

Ecological Engineering

- Global Achievment of economy that appears to be environmentaly sustainable by 2050
- Ecological engineering - a promising step towards sustainable development
- Ecological engineering – ranked eight among the 20 most important strategies for future development
- “Shell-game” with pollution
- Concluding the “Shell – game” with biological system based engineering
- Ecological Engineering – importance in developing countries

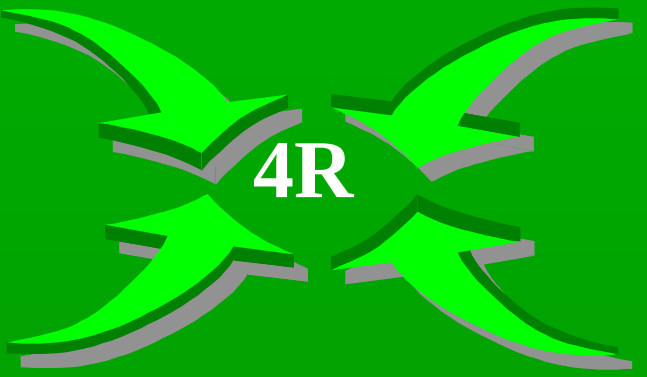
FUNDAMENTALS OF ECOLOGICAL ENGINEERING

- Holism
- Harmony
- Self-resiliency
- Regeneration and circulation


CONVENTIONAL ENGINEERING
Fossil Fuels
Conventional Engineer
Natural Energies
Services to society
ECOLOGICAL ENGINEERING
Fossil Fuels
Ecological Engineering
Self design
Natural Energies
Services to society

The 4 R concept

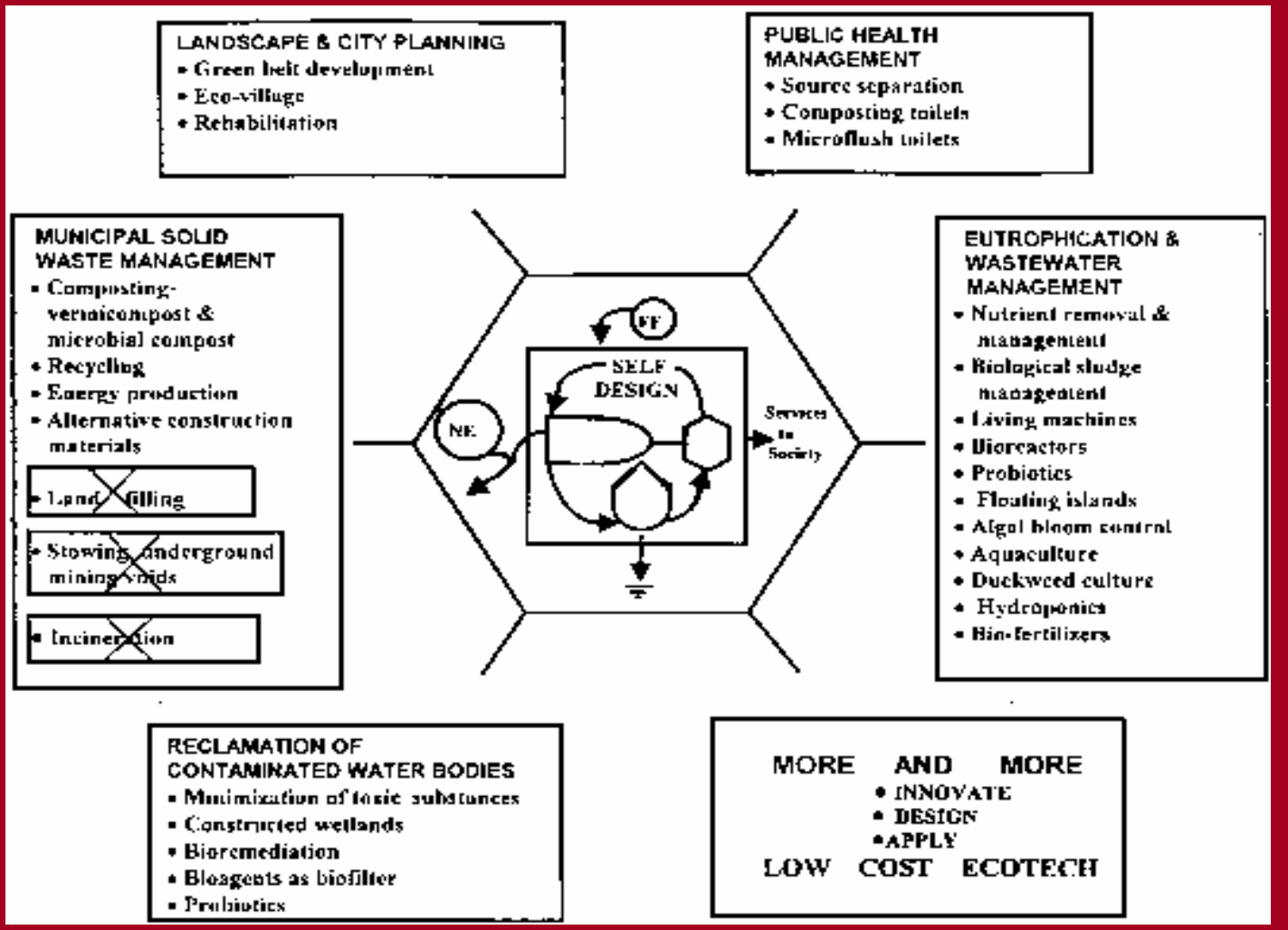
- Reuse
- Refuse
- Recycle
- Rehabilitate



Wastes into Wealth

- Referred as resource out of place
- Should not remain unutilized, but be returned to earth
- Recycling and reuse converting wastes into wealth
- Integrated cross disciplinary approach
- Living machines

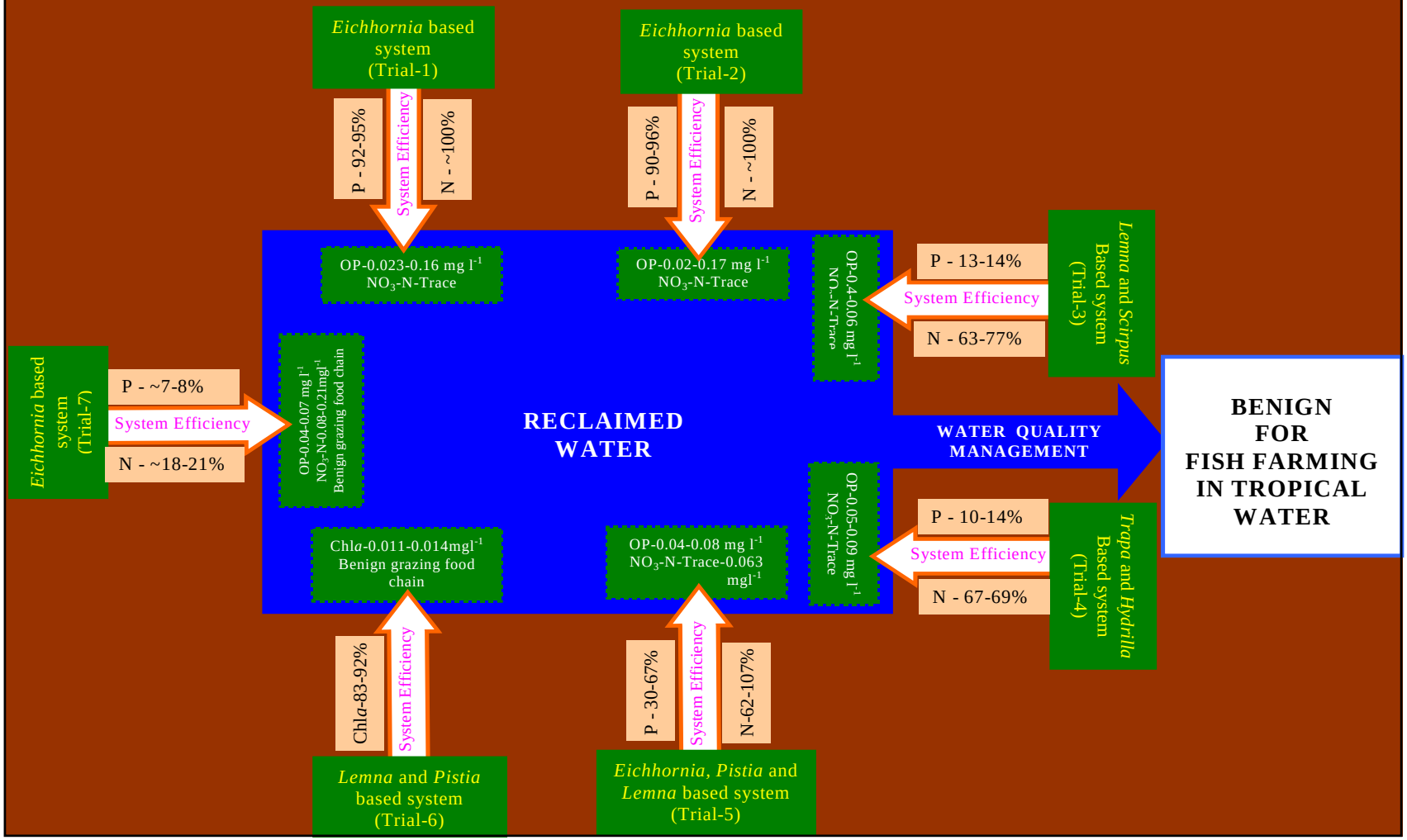
Application area



Waste Management Hierarchy

- ✧Prevent waste generation
- ✧ Reduce the amount of waste generation
- ✧ Reduce the toxicity or negative impact of the wastes
- ✧ Reuse the materials recovered from the waste stream
- ✧ Recycle composed or recover materials for use: as direct new inputs to new products
- ✧ Recovered energy by incineration, anaerobic digestion or similar process
- ✧ Reduce the volume of waste prior to disposal
- ✧ Dispose of waste in an environmentally sound manner

Beneficial effects of macrophytic reclamation and possible reuse of reclaimed waters for fish farming



Output of Eco-village Concept

- ➲ Development of village with ecologically sustainable land and water habitats.

➲ Number of ponds have been improved ecologically in terms of pollution, their use in aquaculture, etc.

➲ Zero-discharged domestic wastes recycled and used in agriculture with integrated fish farming system.

➲ Unused ponds have been used for rain water harvesting.

➲ Environment consciousness among the villagers in all age-groups, irrespective of sex for sustainable development.

➲ Composting system of other wastes such as kitchen waste.

➲ Socio-economic and ecological development of the community.

ECO-VILLAGE - Towards sustainability

Development Package

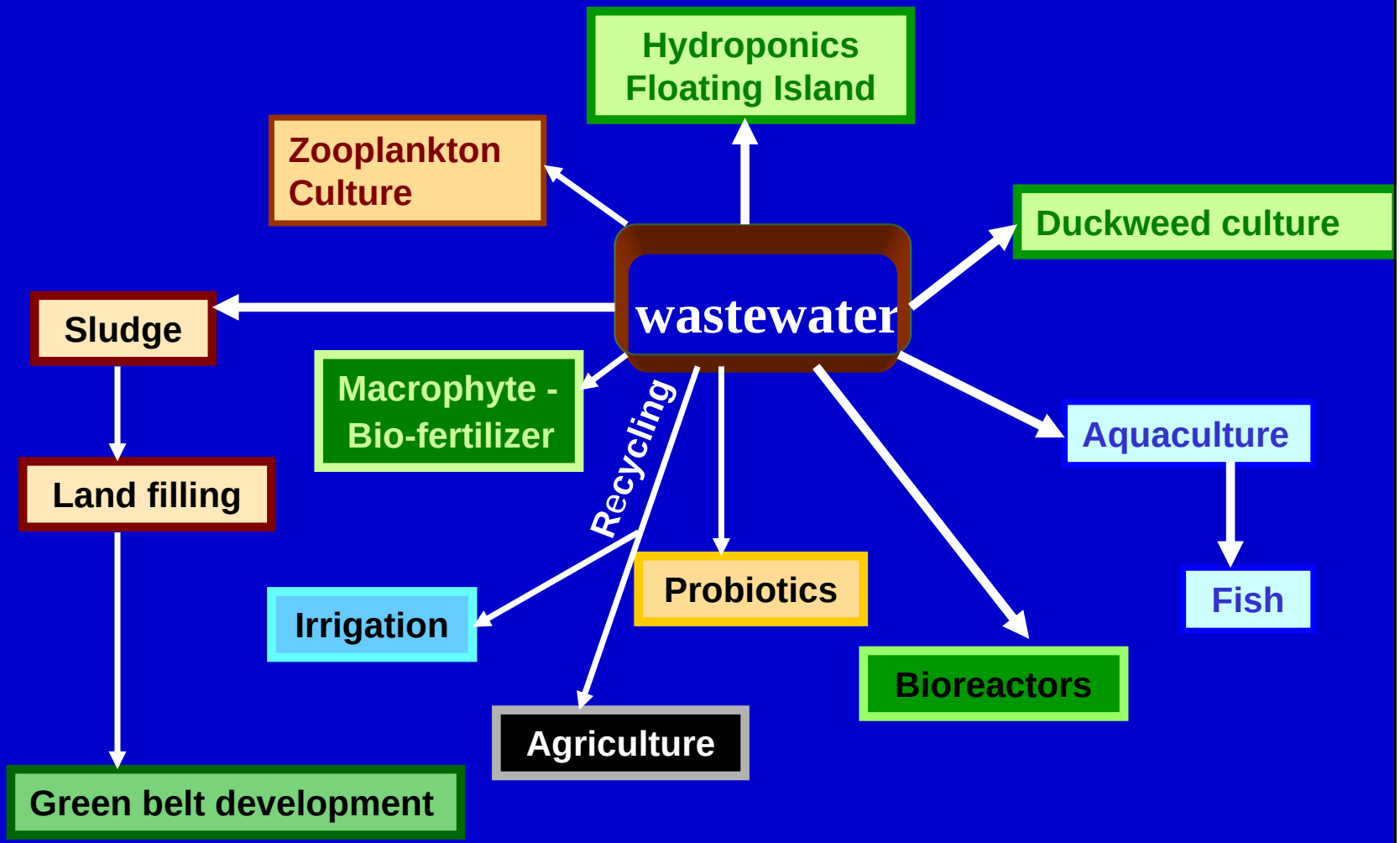
- Community sensitization
  - Environmental Education
  - Mass media
  - Advertising/Hoarding
- Recycling kitchen refuges - vegetable garden
- Promoting organic farming
- Avoiding use of agro-chemicals
- Promoting cultivation of medicinal herbs & spices
- Enhancing green belt & green roof
- Rewarding clean agricultural produces
- Refusing non-degradable articles including plastic bags
- Restoring natural environment
- Keeping environment clean
- Preventing vehicular pollution
- Preventing soil erosion

Community Sensitization

Strategies

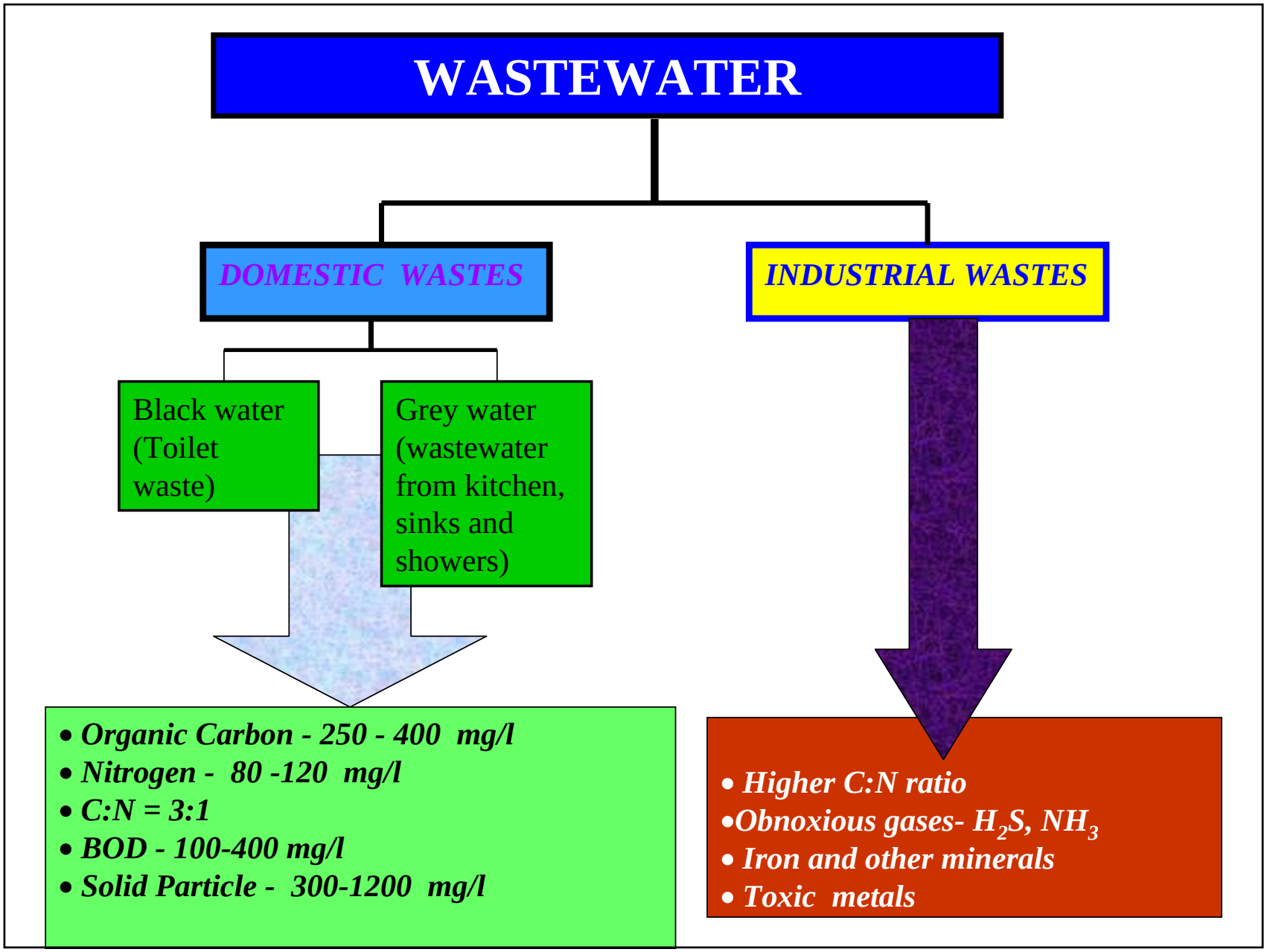
- Frequent audio-visual demonstrations about the eco-village concept among the villagers
- Conduct training programme at the community and Gram Panchayat levels.
- Select the interested and progressive house owners to participate in pilot projects.
- Conduct household wise pilot projects depending upon the resource availability.
- Organize workshop to disseminate the idea and results of the pilot projects.

A Holistic Approach Towards Sustainability



Some Conceptual Models

- ✓ ARTIFICIAL ISLAND using macrophytes - wastewater purifier
- ✓ HYDROPONICS a tool to use wastewater for economic development
- ✓ USE OF HERBIVOROUS FISHES biocontrol of algal bloom
- ✓ USE OF BIVALVES heavy metal bio-filtering
- ✓ USE OF MICROBES IN WASTEWATER TREATMENT- probiotics
- ✓ IRRIGATION OF USED WATER IN KITCHEN GARDEN -water reuse and conservation
- ✓ WASTEWATER AQUACULTURE wastes into wealth
- ✓ FISH CULTURE food security
- ✓ INTEGRATED HOLISTIC APPROACH sustainable eco-development


WASTEWATER
DOMESTIC WASTES
INDUSTRIAL WASTES
Black water (Toilet waste)
Grey water (wastewater from kitchen, sinks and showers)
• Organic Carbon - 250 - 400 mg/l
• Nitrogen - 80 -120 mg/l
• C:N = 3:1
• BOD - 100-400 mg/l
• Solid Particle - 300-1200 mg/l
• Higher C:N ratio
•Obnoxious gases- H_2S, NH_3
• Iron and other minerals
• Toxic metals

Potential Waste Resources

Solid wastes

Agro-industrial
waste
Municipal wastes
Fruit market waste
Vegetable market waste
Fish market waste
Meat market waste
Human waste
Agricultural wastes
Sewage
Hospital waste
Dairy waste
Breweries waste

Liquid wastes

Soft drink industries
Hard industries
Sugar mill
Dairy farm
Domestic sewage
Breweries industries
Beverage

Why to use sewage water in aquaculture?

- Store house of fertilizer- carbon, nitrogen and phosphorus
- Profitable in biological productions through recycling
- Utilization of the sewage in aquaculture is an important profitable proposition
- Fish grows rapidly in tropical country on wastewater
- Replace supplementary diets and chemical fertilizers
- Wastewater aquaculture can mitigate nutrient enrichment and maintain eco-friendly balanced ecosystem

Sewage production in major cities of India

C x P x N = TP

100 l x 10^6 x 142 =14200 x 10^6 l sewage day/1

[C=per capita sewage production per day

P= average production of Class-1 cities

N=No. class -1 cities; and TP = Total sewage production per day]

Calcutta scenario

C x P = TP

100l x 11x 10^6 l per day

- Equivalent to

5.5 tones of nitrogen

1.7 tones of phosphorus

3.3 tones of potash

Worth
of Rupees 7.0 million

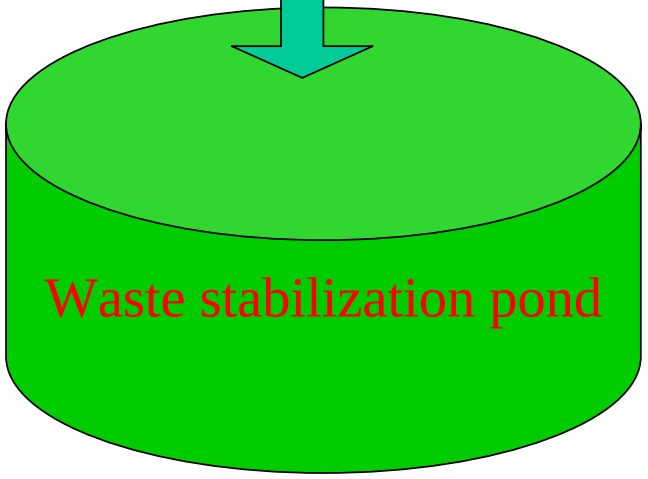
We could recover a huge quantum of nutrients from domestic sewage

Methods of sewage treatments

Principal Methods

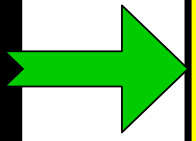
- Dilution
- Land treatment and irrigation
- Sedimentation
- Chemical precipitation
- Magnetic filters
- Trickling filters
- Septic and Imhoff tanks
- Activated sewage method

Other methods



Waste stabilization ponds

- ❶ Anaerobic pond- DO stress
- ❷ Aerobic pond - DO > 2 ppm
- ❸ Facultative pond - aerobic during day and some hours during night. Bottom layer turns anaerobic during remaining hours at night

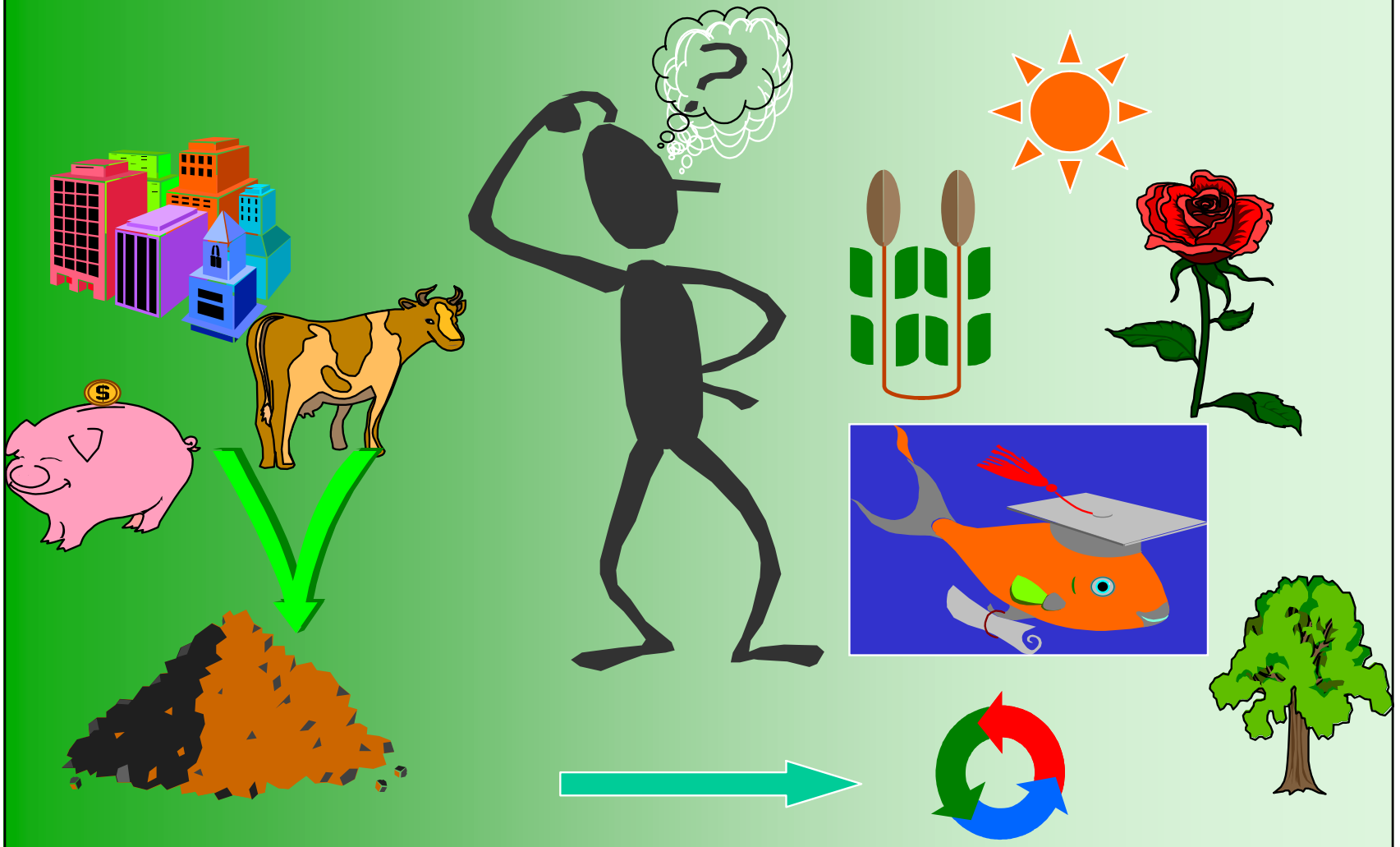


- - a largely recognized process for reduction of organic and bacterial load

Water lily is another important emergent weed used for wastewater reclamation

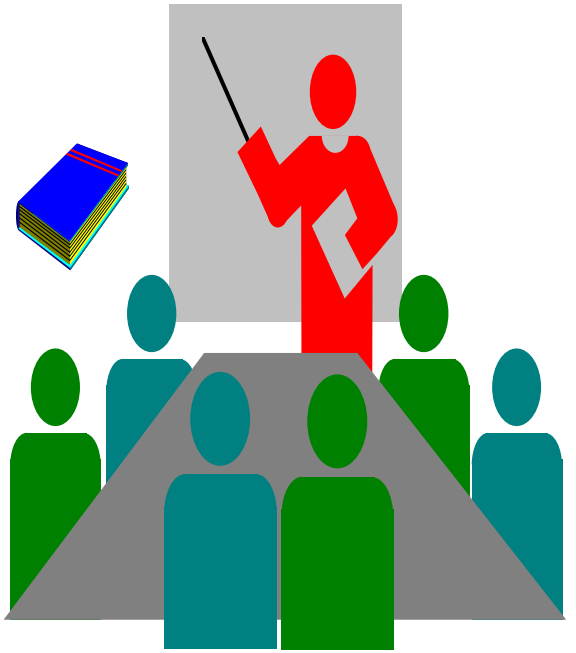
Fish farmers are in a big fish haul in sewage-fed pond

Wastes into Wealth



Socio-economic considerations

- Economic viability
- Food habits of the local people
- Social taboos and acceptance
- Technical know-how
- Environmental awarness
- Limitations



System Upscaling

- Prevent mixing of industrial and domestic sewage
- Design criteria of farm construction
- Retention time of wastewater and sediment saturation capacity
- Data on daily intake of metals and toxicants in fish from all sources
- Public health hazards
- Innovative treatment device and eco-efficiency
- Ecological foot print
- Environmental Education and Public Awareness
- Integrated approach - control of wastewater application, exposure control, promotion of hygiene and wastewater treatment
- Cooperative role with life support system
    - Stakeholders
    - Professionals
    - Innovators
    - Public and political participation
    - Farmers training
    - International cooperation

• Tasks Ahead •

- **Art - of - knowledge and training**
- **International participation**
- **Environmental Risk Assessment**
- **Public Health hazards**
- **City plan**
- **Ganga Action Plan**
- **Conservation of aquatic resources**
- **The Conflicts**
- **End shell- game with pollution**
- **Levels of sustainability**

Rehabilitation Package

- Reclaiming degraded lands and derelict water bodies
- Maximizing the use of biological agents to reclaim habitats
- Accelerating bio-diversity through germplasm
- Conserving water, wetlands and other water resources
- Maintaining a community lifestyle that ensures individual rights while fostering a spirit of community.
- Encouraging individual responsibility to recognize and resolve conflicts
- Developing a sound economic foundation to support a dynamic village
- Harmonizing social life with environment

International Centre of Ecological Engineering, University of Kalyani

Inauguration of centre


Thank you
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