Water Management at Agricultural Catchment - Sustainable & Technological Approaches for Pollution Control

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INTRODUCTION

Surface water management at agricultural catchment level is one of the challenging and most difficult tasks due to the multidimensional and non-point contamination sources. Contamination of surface water by various emerging pollutants released from agricultural has drastically increased due to difficulties in identification of contamination type and sources.

Plant protection Products (PPPs)

- Plant Nutrients
- Pesticide
- Insecticides
- Plants residues, etc
PRACTICAL CHALLENGES AT AGRICULTURAL CATCHMENT

- Non-point (Un-defined) pollution sources
- Diversity in pollutant composition
- Diversity in crop pattern
- Diversity in soil/properties
OVERVIEW OF THE STUDY

Preparation of low-cost SORBENTS (LCS)

Characterization

Application of LCS for pollution remediation

Synergetic studies for feasibility

Citizen Science

Management Framework

Regulatory Framework

Modeling Framework

Real-time applications

Implement Framework

WFEE Nexus
LOW-COST & INDIGENOUS ACTIVE LCS FOR POLLUTION REMEDIATION

Rice husk  Water Hyacinth  Coontail  Coconut shell

Cleaning

Husk & trace dust

Shredding

Small pieces

Pyrolysis

In muffle furnace
(T-800°C, 5-8 h)

Soaking

in CaCl₂
24h

Grinding & Sieving

Activate Sorbents

Pyrolysis

In muffle furnace
(T-900°C, 1 h)

Drying

In hot air oven
(T-75°C)
CHARACTERIZATION OF ACTIVE LCS

SORPTION PROPERTIES

• Porosity and surface area
• Surface functionality
• Morphology
• Chemical stability
• Chemical composition (Redox), etc

SEM images

FTIR spectrum

BET surface area

Activated husk based Biochar

Volume adsorbed (cc STP/g)
Relative Pressure (P/P₀)
APPLICATION OF LCS FOR REMEDIATION OF POLLUTANTS (PPPs, etc)

Water infiltration: 1-1.5 mm²/day (after saturation with normal evaporation)
Total duration: 30 days
LCAs load: 20 wt %
REAL-TIME APPLICATION OF LCS FOR POLLUTION (Pilot Scale)

Flushing and Residence time

15 cms

2 x 5 ft horizontal sections

2 x 5 ft horizontal section with bunds

Leaching (by sorption) mitigation (in %)

Pollutants (PPPs)

With LCAs
Without LCAs

Nitrite Nitrate Cd Pb Paraquate Phorate Phosphamidon

50 % 71 % 80 % 82 % 75 % 73 % 55 %

52 % 72 % 81 % 84 % 77 % 77 %
SYNERGETIC STUDIES

Seed germination
Nutrition management
Consistency
Erosion & fertility

Soil with 20 wt % of LCS

Soil without LCS

Plant growth rate (Visual Index)

<table>
<thead>
<tr>
<th></th>
<th>Without LCS</th>
<th>With LCS</th>
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</thead>
<tbody>
<tr>
<td>Vigna mungo (Black gram)</td>
<td>Averaged (8)</td>
<td>Good (13)</td>
</tr>
<tr>
<td>Cicer arietinum (Chickpea)</td>
<td>Averaged (9)</td>
<td>Extraordinary (16)</td>
</tr>
<tr>
<td>Poor (1-5); Average (6-10); Good (11-15); Extraordinary (16-20)</td>
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Height
Stem size
Tissue volume
Fresh weight
Dry weight
Leaf size/Number
Color
CITIZEN SCIENCE AND PARTICIPATORY APPROACHES

Implementation of Novel Framework for Surface Water Management in Agricultural

- SKILLS
- ATTITUDE
- EDUCATION
- PARTICIPATORY
- SOCIAL
- ECONAMICAL
- ETHICAL
- LEGAL

Convincing Approaches

- Economic
  - 71%
- Social
  - 11%
- Environmental
  - 16%
- Ethical
  - 03%

BEHAVIORAL CHANGE

IMPLEMENTATION OF NOVEL FRAMEWORK

Water Pollution Remediation
NOVEL FRAMEWORK AND DYNAMIC INTERACTIONS ACROSS THE WATER-ENERGY-FOOD-ENVIRONMENTAL NEXUS

WATER

ENERGY

SURFACE WATER

GROUND WATER

SUSTAINABLE DEVELOPMENT & ECOSYSTEM CONSERVATION

Technological

Citizen-Science

Regulatory

Modelling

NOVEL FRAMEWORK

ENERGY

Socio-economic condition

Health

Sustainability

WATER

SOIL FERTILITY

QUALITY

WATER POLLUTION

FOOD PRODUCTION

FOOD QUALITY

FOOD

Energy Usage

Soil Fertility

Quality

Water Pollution

Food Production

Food Quality

ENVIRONMENT

Sustainable Development & Ecosystem Conservation

Technological

Citizen-Science

Regulatory

Modelling
CONCLUSIONS

The integrated technological approaches can be implemented at catchment level for the potential management and mitigation of water contamination by undefined sources.

Self-sustaining remediation technique using low-cost and indigenous SORBENTS at agricultural catchments has great advantages both in sustainable crop management and surface water conservation.

Citizen science and understanding the dynamic interactions across the water-energy-food-environmental nexus can be used for the strengthening the safe and technological frameworks for surface water management at agricultural catchment level.

THANK YOU FOR YOUR ATTENTION