4. Kuttanad Rice – Geography

"Recent soil tests in Kuttanad, the rice bowl of Kerala, have found alarmingly high concentrations of aluminium in paddy fields, as reported by the State Pest Surveillance Centre/KCPM.

1. Key Scientific Findings

Soil tests conducted by the Kerala Centre for Pest Management (KCPM) detected aluminium concentrations ranging from ~77 ppm to 330 ppm in paddy soils of Kuttanad. These values are 39 to 165 times higher than the safe threshold of 2 ppm recommended for rice cultivation. Such concentrations indicate severe soil chemical degradation, not merely marginal acidity.

2. Causes of High Aluminium Levels in Kuttanad Soils

A. Acid Sulphate Soil Conditions

Kuttanad is dominated by acid sulphate soils, where -

1. Soil pH frequently falls below 5.
2. At such low pH levels, aluminium becomes highly soluble, increasing plant toxicity.

Aluminium toxicity is thus chemically triggered, not externally introduced.

B. Below Sea-Level Farming and Waterlogging

Farming is carried out 1–2 metres below mean sea level, protected by bunds. Prolonged waterlogging and poor drainage -

1. Intensify anaerobic soil conditions.
2. Facilitate chemical reactions that release exchangeable aluminium into soil solution.

C. Oxidation of Sulphides (Pyrite Oxidation)

Drainage or drying of wetland soils exposes iron sulphides (pyrite) to oxygen. This leads to -

1. Formation of sulphuric acid.
2. A sharp decline in soil pH.

This is a classic feature of acid sulphate soil degradation, seen globally in reclaimed wetlands.

D. Fertiliser-Induced Acidification

Long-term application of ammonium-based fertilisers -

1. Releases hydrogen ions during nitrification.
2. Further acidifies soils already vulnerable to low buffering capacity.

This accelerates aluminium mobilisation.

E. Decline in Liming and Soil Conditioning

Inadequate or irregular liming in recent years has -

1. Reduced calcium and magnesium availability.
2. Allowed acidity to accumulate unchecked.

This weakens soil resilience against toxic metal release.

F. Flooding, Leaching, and Climate Stress

Recurrent floods -

1. Leach away base cations (Ca^{2+}, Mg^{2+}, K^{+}).
2. Remove natural acidity buffers.

Climate change–induced extremes -

1. Intense floods followed by prolonged dry spells.
2. Accelerate acidification–oxidation cycles in wetland soils.

3. Impacts on Agriculture and Food Security

A. Root Damage and Plant Stress

Aluminium toxicity -

1. Severely damages rice root systems.
2. Restricts root elongation and branching.

This directly reduces -

1. Water uptake
2. Nutrient absorption
3. Overall plant vigour

B. Nutrient Lock-up and Deficiencies

Aluminium interferes with the uptake of -

1. Phosphorus
2. Calcium
3. Potassium
4. Magnesium

This leads to secondary nutrient deficiencies, even when fertilisers are applied.

C. Secondary Metal Toxicity

Highly acidic soils also increase iron solubility. Excess iron causes -

1. Leaf bronzing
2. Oxidative stress
3. Further yield decline

Thus, aluminium toxicity is compounded by iron toxicity.

D. Yield Loss and Seasonal Risk

The combined effects result in - Significant decline in paddy yields.

Puncha season (dry-season crop) -

1. Already stressed due to fertiliser shortages.
2. Now faces heightened risk from soil toxicity.

E. Regional Food Security Concerns

Kuttanad is Kerala's "rice bowl". Sustained productivity loss threatens -

1. State-level rice self-sufficiency.
2. Livelihoods of small and marginal farmers.
3. Price stability and nutritional security.

4. Kuttanad Wetland Agricultural System - Geographic and Ecological Context

A. Location and Physical Setting

Situated in Kuttanad region of Kerala, spanning -

1. Alappuzha
2. Kottayam
3. Pathanamthitta districts

Surrounds the Vembanad Lake, a Ramsar wetland.

B. Unique Agro-Ecological Features

One of the world's few farming systems below sea level. Protected by -

1. Bunds
2. Embankments
3. Controlled sluice gates

Characterised by reclaimed wetlands and polders (Padasekharams).

C. Traditional Water Management

Community-managed -

1. Manual sluice operations
2. Seasonal drainage
3. Salinity and flood control

Reflects high levels of indigenous hydrological knowledge.

D. Cropping and Livelihood System

Dominated by synchronised paddy cultivation. Integrated livelihoods -

1. Rice farming
2. Fisheries
3. Livestock
4. Inland navigation

Enhances income diversification and resilience.

E. Ecological Significance

Integral part of the Vembanad wetland ecosystem. Provides -

1. Flood buffering
2. Nutrient cycling
3. Biodiversity habitat

Acts as a natural climate adaptation system.

5. FAO Recognition - GIAHS Status

Declared a Globally Important Agricultural Heritage System (GIAHS) in 2013 by the Food and Agriculture Organization (FAO).

About GIAHS

Initiated - 2002

Objective -

1. Conserve living agricultural heritage.
2. Protect agro-biodiversity and traditional knowledge.
3. Promote sustainable livelihoods and food security.

Key Features of GIAHS Sites

1. Rich agro-biodiversity
2. Indigenous knowledge systems
3. Climate-resilient farming practices
4. Strong human–nature interaction

Difference from UNESCO World Heritage Sites

GIAHS focuses on living, productive systems. Emphasises dynamic conservation with development, not static preservation.

6. Policy and Conservation Imperatives

Soil restoration measures -

1. Scientific liming schedules
2. Improved drainage management
3. Balanced fertiliser use

Climate-adaptive wetland management -

1. Flood-resilient infrastructure
2. Salinity and acidity monitoring

Institutional support -

1. Strengthening padasekharam committees
2. Integrating traditional knowledge with modern soil science

National relevance -Aligns with sustainable agriculture, climate resilience, and food security goals.

Source - [https -//www.thehindu.com/news/national/kerala/soil-tests-in-kuttanad-paddy-fields-show-aluminium-levels-39-to-165-times-above-safe-limits/article70422648.ece](https://www.thehindu.com/news/national/kerala/soil-tests-in-kuttanad-paddy-fields-show-aluminium-levels-39-to-165-times-above-safe-limits/article70422648.ece)