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Sustainable Rice and Wheat-Based Cropping Systems in India: Trends, Practices, and Ecological Impacts

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India's Green Revolution brought significant increases in food production, particularly rice and wheat. However, the focus on monoculture, heavy fertilizer use, and loss of traditional varieties has led to environmental degradation and loss of biodiversity. This paper reviews rice- and wheat-based cropping systems across various agro-climatic zones in India, highlighting diversified, intercropped, and sustainable models, along with their impact on soil health, productivity, and climate resilience.

Keywords: Rice-based systems, Wheat-based systems, Cropping diversification, Intercropping, Relay cropping, Sustainable agriculture, Soil health, Agroecology, India

Introduction

The Green Revolution, initiated in the 1960s, addressed food insecurity in India by introducing high-yielding varieties (HYVs) of rice and wheat. While it succeeded in boosting crop production, especially in densely populated regions, it came at the cost of agrobiodiversity and soil health. Traditional practices, including crop rotation and organic husbandry, declined as monocultures and chemical fertilizers became dominant. India has since shifted toward the "evergreen revolution," emphasizing ecologically sustainable, socially inclusive, and economically viable agricultural practices. This article focuses on rice- and wheat-based cropping systems, their types, regional patterns, and effects on productivity and soil properties.

Cropping System Types in India

Cropping systems vary by climatic conditions, soil type, and socioeconomic context. Major types include:

- Monocropping
- Intercropping
- Sequential Cropping
- Crop Rotation
- Alley Cropping
- Relay Cropping

Rice-Based Cropping Systems

India grows rice across diverse agro-ecological zones. Key rice-based systems include:

- Rice-Wheat (Indo-Gangetic Plains)
- Rice-Pulse/Oilseed (Eastern and Southern states)
- Rice-Rice (Coastal and irrigated regions)

Intercropping and Mixed Cropping: Mixed cropping of early (ahu) and late (bao) rice in flood-prone Assam and koottumundakan rice cultivation in Kerala improve yield and lower costs. Intercropping rice with soybean improves productivity when paired with weed control.

Sequential and Relay Cropping: Relay systems like rice-lathyrus/lentil utilize residual soil moisture. Utera cropping improves productivity in fallow lands.

Irrigated Systems: Triple cropping such as rice–rice–vegetables or rice–rice–pulses enhances land use.

Productivity and Soil Impact: Legumes in rice sequences improve soil organic carbon, microbial activity, and nutrient status.

Wheat-Based Cropping Systems

Wheat is mainly grown in Northern and Central India. Common systems:

- **Wheat-Fallow-Maize-Potato**
- **Wheat-Green Pea-Summer Moong Bean**

Intercropping: Wheat intercropped with legumes or vegetables (e.g., radish) improves yield and income.

Nutrient Management: Combining FYM with fertilizers improves NPK levels. Wheat–mung bean–maize systems show high productivity.

Regional and System-Specific Observations

Kerala: Rice–rice–amaranthus and rice–rice–sweet potato are highly productive in wetlands. Fish integration enhances yields by 15.5%.

Drought-Prone Areas: Aerobic rice systems and use of PPFM bacteria improve drought tolerance and crop performance.

Environmental Considerations

Puddling for rice damages soil structure, reducing porosity and yield in subsequent wheat crops. Over 1 lakh traditional rice varieties have been lost. Restoration of cropping diversity is critical for climate resilience.

Conclusion

Cropping systems are evolving from productivity-only models to those prioritizing ecological and economic sustainability. Intercropping, rotations, and conservation practices must be region-specific. Promotion of research-backed models is essential for ensuring long-term food security and soil health.

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