



## Review Article

## Toward sustainable phosphorus management in Sri Lankan rice and vegetable-based cropping systems: A review

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## ABSTRACT

Upland soils used for vegetable cultivation and lowland soils used for rice cultivation in Sri Lanka are inherently low in phosphorus (P) availability for plants. Rice is grown twice a year while vegetables are grown in intensive rotations. Heavy doses of inorganic and organic P sources are regularly applied to vegetable cultivating systems aimed at maximizing productivity, and disregarding the relatively lower P fertilizer application rates recommended by the government Department of Agriculture. This practice has led to the development of high P concentrations in intensive, high-value vegetable cultivating systems which is threatening environmental sustenance (267 mg available P/kg of soil). For rice, only inorganic P sources are widely being applied and the excessive soil P loading is less severe than that in vegetable cultivating systems (13 mg available P/kg soil). However, rice crops grown in most of the lowlands do not show positive responses to added P fertilizers. The development of chronic diseases among the inhabitants in certain intensively rice cultivated regions in Sri Lanka is suspected to be due to the presence of high concentrations of heavy metals in P fertilizers and the accumulation of those in food chains. Despite sustainable and updated P fertilizer recommendations being available, farmers continue to apply overdoses of P, seeking higher crop yields. Therefore, coordination and active intervention of all the related institutes are required when improving the awareness of farmers on this malpractice, and ensuring the sustainability of vegetable and rice cultivating systems in Sri Lanka with respect to P nutrition.

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## Introduction

Sri Lanka has three climatic zones; a 'Wet Zone' in the South-Western region, a 'Dry Zone' covering predominantly the Northern, North Central, Eastern and South-Eastern plains of the country, and an 'Intermediate Zone', skirting the central hills except in the North-West and the South as shown in Fig. 1 (Punyawardena, 2007). The Dry Zone receives mean annual rainfall of less than 1750 mm with a distinct dry season from May to September. The Intermediate Zone receives mean annual rainfall between 1750 and 2500 mm with a short and less prominent dry season, while the Wet Zone receives an annual rainfall of more than 2500 mm. With respect to crop cultivation, there are two major seasons coinciding

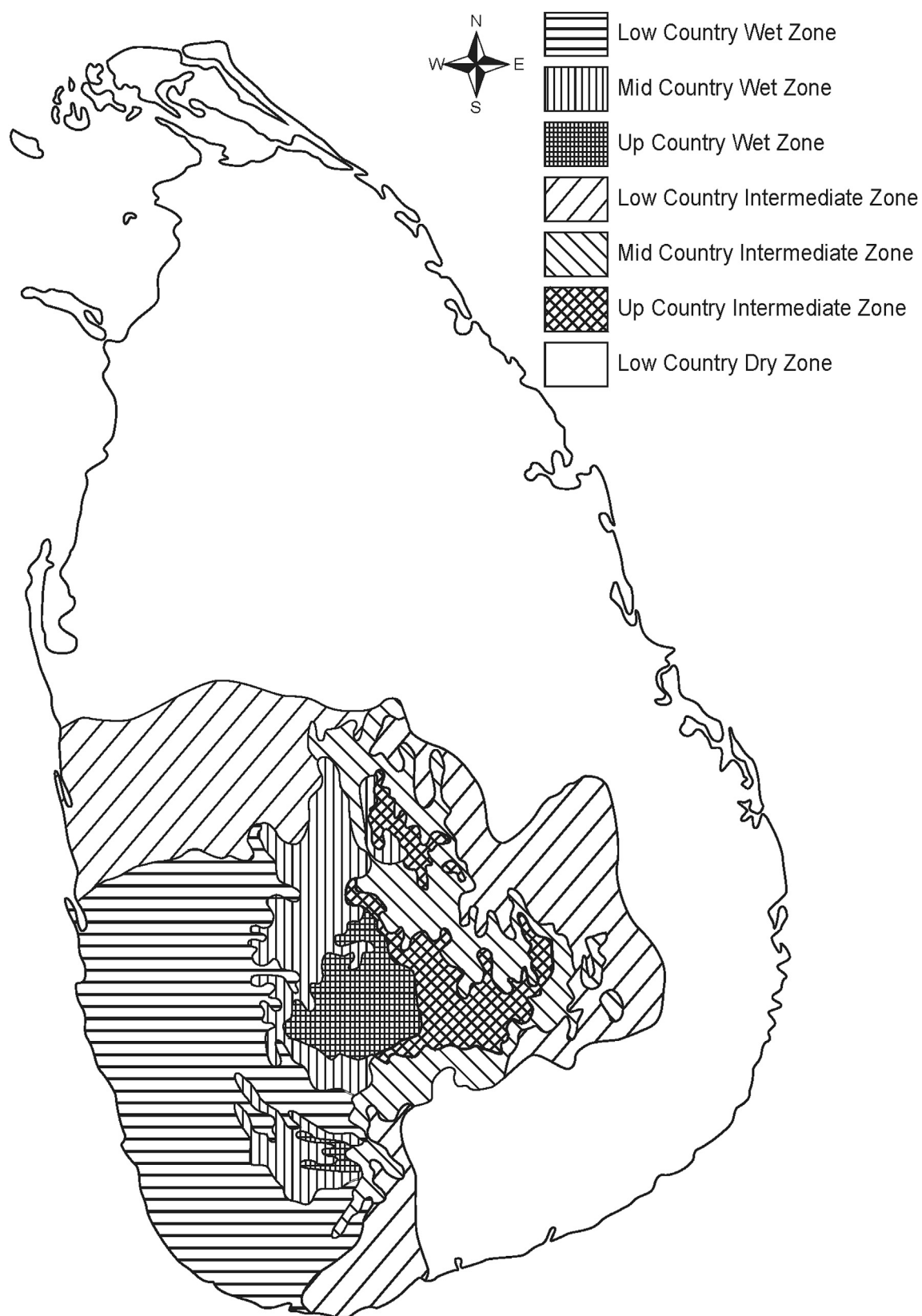
with the 'major rainy season' from November to January and the 'minor rainy season' from May to July. Ultisol is the major soil group in the Up-Country (elevation >900 m above mean sea level) vegetable growing regions, and Alfisol is the major soil group in rice-based (*Oryza sativa* L.) cropping systems in the Low-Country Dry and Intermediate Zones (Mapa et al., 2010). Currently, more than 2 million ha (approximately 30% of the country's land extent) are under some form of agriculture (Wijewardena, 1996; Department of Agriculture, 2013). Rice is grown as a lowland crop across the country. Vegetables are intensively cultivated in uplands and in lowlands when the water available for rice cultivation is not adequate (Wijewardena, 1996). Due to the intensification of crop production in the past few decades and the application of inorganic phosphorus (P) fertilizers and organic manures, soil fertility has altered (Dissanayake and Chandrajith, 2009). Despite the increased crop productivity, public concerns on environmental sustenance and quality of life have also increased (Dissanayake and Chandrajith, 2009; Jayasumana et al., 2013). Therefore, this

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**Fig. 1.** Schematic representation of the seven agro-climatic zones of Sri Lanka, where categorization is based on elevation above mean sea level (Low Country < 300 m, Mid Country = 300–900 m and Up Country > 900 m) and annual rainfall zones (Dry < 1750 mm, Intermediate = 1750–2500 mm and Wet > 2500 mm; sourced: [Punyawardena, 2007](#)).

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