

Management influence on maize–wheat system performance, water productivity and soil biology

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Abstract

Cereal cropping productivity in the Indo-Gangetic Plain (IGP) of India is declining, which may be overcome by diversification, alternate crop establishment methods and mulching. This study was conducted to determine whether no-till flat (NTF), permanent raised beds (PRB) and nontraditional *ex situ* mulching would improve crop and water productivity, economic profitability and soil biological properties in an irrigated maize (*Zea mays*)–wheat (*Triticum aestivum*) system (MWS). NTF systems produced 10% higher economic net returns compared with PRBs. Non-traditional mulching (*Sesbania*, *Jatropha* and *Brassica*) increased yields by >10% and net returns by >12% compared with no-mulch. The water saving in PRBs compared with NTF systems was 79, 94 and 173 mm/ha in maize, wheat and MWS, respectively. PRBs saved 29.2% of irrigation water and improved the MWS irrigation water productivity (WP_I) by 24.5% over NTF. On average, mulching saved 23.8 mm/ha irrigation water over no-mulch and improved WP_I by 12.0%. PRBs with *ex situ* mulching produced wheat and maize equivalent system yields lower than NTF but improved WP_I and soil biological properties. *Jatropha* and *Sesbania* mulching improved yield, water saving, WP_I and system profitability. In limited irrigation and no crop residue availability conditions, *Sesbania*, *Jatropha* and *Brassica* vegetation material have potential applications for *ex situ* mulching under PRBs for water saving and NTF for productivity.

Keywords: Maize–wheat system, crop yields, water productivity, economic profitability, soil biological properties

Introduction

The Indo-Gangetic Plain (IGP) of India, covering about 44 Mha, is the most important food-producing region of South Asia. It is dominated by cereals, of which irrigated maize–wheat systems (MWS) are the third most important (1.13 Mha) cropping system after rice–wheat and cotton–wheat systems (Yadav & Subba Rao, 2001). Rice–wheat systems (RWS), a major contributor to total cereal production, occupy about 10.3 Mha area (Ladha *et al.*, 2003) and account for 23 and 40% of the total rice and wheat area in India, respectively.

However, continuous intensive cultivation of rice and wheat in the western IGP has resulted in declining productivity, profitability and yield growth. Excessive exploitation of groundwater for meeting the high water requirement of RWS has resulted in a fast water table drawdown in many areas of North-West (NW) India (Rodell *et al.*, 2009). RWS are crucial for the country's food security, but to ensure sustainability of natural resources and crop production in dark zones (over-exploited groundwater zones) of the NW IGP, diversification of rice by crops requiring less water, crops such as maize, is essential.

Mere replacement of rice with maize without suitable management practices for MWS will not help with diversification. Crop establishment methods and tillage practices affect labour costs, economic returns and soil properties under any crop production system. The