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A comparative analysis of rice–wheat systems in Indian Haryana and Pakistan Punjab

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ABSTRACT

Intensive irrigated rice–wheat production systems have converted the north-west Indo-Gangetic Plains into South Asia's cereal basket. Their strategic importance is undermined by a slowdown in productivity growth linked to the degradation of soil and water resources. Findings from farm surveys are used to examine contrasts and similarities between rice and wheat farms, cultivation practices, productivity, and profitability in the rice–wheat belt of India's Haryana State and Pakistan's Punjab province. In Haryana average wheat and paddy yields are markedly higher, but the yield advantage is offset by higher total production costs, resulting in lower private returns. The diverging institutional environment including varying levels of intervention in produce and input markets contributed to the evolution of the Pakistani production model as relatively 'medium input–medium output' and the Indian production model as 'high input–high output'. The study reiterates the need to reinvigorate productivity growth and to reduce production costs in these intensive cereal production systems while conserving natural resources such as water and limiting negative environmental impacts. The study however also raises questions about the future of current rice–wheat systems.

Introduction

In South Asia, rice–wheat production systems encompass 13.5 million hectares, with the bulk in India (10 M ha) and Pakistan (2.2 M ha, Timsina and Connor, 2001). The cropping system is primarily irrigated and witnessed significant yield increases during the Green Revolution with the spread of semi-dwarf crop varieties and complementary technologies – including fertilizer and irrigation – and policy support, thereby contributing to an impressive increase in supply from 1965 to 1985 (Byerlee et al., 2003; Byerlee and Siddiq, 1994; Murgai et al., 2001). The intensive rice–wheat systems in the northwest Indo-Gangetic Plains (NW IGP) has made this into South Asia's cereal basket and of strategic importance for regional and national food security.

The future role of South Asia's intensive rice–wheat systems is being undermined by a slowdown in productivity growth (Duxbury, 2001; Kataki et al., 2001; Ladha et al., 2003; Prasad, 2005). Input growth accounted for most of the systems' output growth since the advent of the Green Revolution (Murgai et al., 2001), yet total factor productivity growth has slowed over time (Kumar et al., 1999). Rice–wheat systems had the lowest rates of total factor productivity growth compared to other wheat-based systems (Ali and Byerlee, 2002; Murgai, 1999; Murgai et al., 2001). This underperformance is associated with the degradation of soil and water resources induced by the intensification of these cereal production systems and its alternating aerobic wheat and anaerobic rice crops.

Byerlee et al. (2003) have decomposed yield trends in Pakistan's rice–wheat systems since the advent of the Green Revolution. They show the negative effect of resource degradation on yields after accounting for the effects of the adoption of modern varieties and fertilizer. This was further confirmed by analysis of soil data, where soil organic matter and soil P were declining, while salinity in soil and water samples was increasing (Byerlee et al., 2003). The effects of resource degradation thereby offset the positive productivity effects of improved technology and investment in infrastructure and literacy (Ali and Byerlee, 2000; Byerlee et al., 2003).

The rice–wheat systems in the NW IGP show some striking similarities: the prevalence of irrigation and double cropping; high chemical fertilizer use; widespread mechanisation; a commercial orientation; and an increasing reliance on groundwater. Still, despite the apparent similarity there can be significant local variation. We hypothesize that the diverging institutional environment in Pakistan and India has affected the evolution of these irrigated rice–wheat systems. Agricultural statistics indeed suggest substantial differences in performance and in the sources of growth in the two countries. Although output growth and crop yields were much

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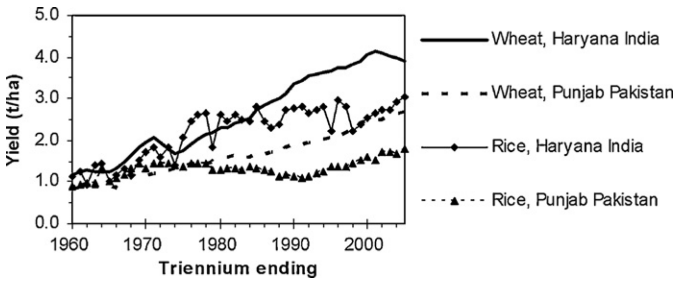

Fig. 1. Wheat and rice yields in the north-west Indo-Gangetic Plains. *Source*: Compiled from unpublished government statistics.

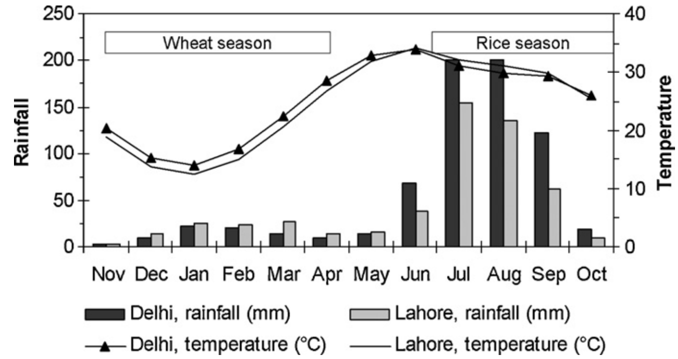

Fig. 2. Seasonality in the north-west Indo-Gangetic Plains. *Note*: Long term average monthly rainfall and temperature (24-h). Delhi weather station (28.58°N 77.20°E 211 m above sea level) is located just south of the Haryana study area; Lahore weather station (31.55°N 74.30°E 214 m) is located within the Punjab study area. *Source*: http://www.worldclimate.com/.

higher in India, total factor productivity growth was higher by only a small margin (Murgai et al., 2001). Murgai et al. (2001) associate the more rapid productivity growth in India with differential public investments in rural infrastructure, human capital, and research and extension. They downplay the contribution of price policies toward agriculture, since both countries subsidize fertilizer, credit, power and irrigation inputs. Still, the extent of the policy distortion differs: for instance, fertilizer subsidies are markedly higher in India (Heffer and Olegario, 2008). Similarly, both countries have variously intervened in wheat and rice markets (Dorosh and Salam, 2008; Jha et al., 2007) and variously liberalized their economies over time—Pakistan first and India only following in the 1990s (Dorosh and Salam, 2009; Pursell et al., 2009).

The quest for appropriate responses to the challenges facing rice–wheat systems will thereby be aided by better understanding farmers' practices and the incentives they face on each side of the border. We examine intensive irrigated rice–wheat systems in India's Haryana State and Pakistan's Punjab province drawing from an empirical farm survey in the rice–wheat belt of the irrigated NW IGP. We analyse selected indicators of farm characteristics, crop management, productivity, and profitability and discuss these in relation to the diverging institutional environment and explore the implications.

Material and methods

At Pakistan's and India's independence in 1947, Punjab was partitioned into Pakistan's Punjab Province and India's Punjab State. Indian Punjab was further subdivided in 1966 into the relatively flat states of Punjab and Haryana and the mountainous Himachal Pradesh. The geo-political entities of Pakistan Punjab, Indian Punjab and Haryana are all located in the NW IGP and have similar agro-ecological potential, cropping systems and socio-economic conditions. Yet agricultural performance in these regions has diverged during the previous 50 years. Wheat and rice yields are evidence of this divergence, and during the last 30–40 years, rice yields in Haryana (and the Indian Punjab) have generally been higher than those in the Pakistani Punjab (Fig. 1).

The extent of the observed cross-border difference has generated substantial interest (Byerlee et al., 2003; Hussain et al., 2003b; Murgai et al., 2001; Mustafa and Khan, 2005; Mustafa, 2002). Many cross-border analyses rely primarily on secondary data and only a few examine primary data. Most of these studies also contrast the two Punjabs, but in the case of rice this is confounded by the uneven occurrence of low yielding, high value basmati, an aromatic (fragrant) fine-quality rice which takes a longer time to mature (Bhattacharjee et al., 2002). The higher rice yields in the Indian Punjab reflect, in part, the focus on early maturing common rice (non-fragrant) for domestic consumption, whereas in Pakistan Punjab basmati production for export prevails (Byerlee et al., 2003). Haryana is India's leading state in terms of basmati rice exports. In view of the widespread cultivation of basmati in Haryana's rice–wheat systems, a contrast of Pakistan Punjab with Haryana is more appropriate.

The paper compares the rice–wheat zones of Haryana State, northwest India (hereafter referred to as "Haryana") and Punjab Province, northeast Pakistan (hereafter referred to as "Punjab"). The two areas share a continental monsoonal semiarid climate, with some 80% of annual rainfall during the monsoonal season from June to September (Fig. 2). Average annual rainfall is somewhat higher in the Haryana study area (Fig. 2, annual average Delhi 706 mm, Lahore 530 mm), but both areas show a marked rainfall gradient increasing towards the Himalayan foothills to their North (Erenstein et al., 2008). The Punjab study area has a higher northern latitude with a somewhat lower average temperature (Fig. 2, annual average Delhi 25.0 °C, Lahore 24.4 °C). Rice is grown during the warm humid monsoon season and wheat during the cool dry winter season (Fig. 2), with both crops dependent on irrigation which includes the conjunctive use of surface water and ground water (Erenstein, 2009).

This work complements other companion papers in the same two areas. Erenstein et al. (2008) evaluate the on-farm impacts of zero-tillage wheat production and also further introduce and describe the two study areas; whereas Erenstein (2009) particularly evaluates water management. The primary data source for this study and the companion papers is a formal survey of 400 rice–wheat farmers in Haryana and 458 farmers in Punjab during 2003–2004. The survey used a stratified sampling frame, whereby within each country study, sub-districts with predominantly rice–wheat systems were purposively chosen, comprising both districts where zero tillage has been widely and less extensively promoted. In the case of Haryana, 50 villages randomly chosen from the 10 selected sub-districts were surveyed with 8 randomly chosen farm households per village. In the case of Punjab, 51 villages from 11 sub-districts were surveyed with typically some 8–10 farm households per village.

In addition to farm level indicators, we collected crop management details for both wheat and rice plots. In the case of wheat, zero tillage plots and conventional tillage plots were surveyed separately on selected farms (resulting in a total of 499 wheat plots in Haryana and 522 plots in Punjab). In the case of rice, rice plots following zero tillage wheat and rice plots following conventional tillage wheat were surveyed separately (resulting in a total of 468 rice plots in Haryana and 528 plots in Punjab). Erenstein et al. (2008) examine a subset of the surveyed farms, comparing zero tillage with conventional tillage on zero tillage adopter farms only. Here we use the complete data set and specifically focus on the contrasts