Land Use Policy 70 (2018) 212–223

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Adoption and Abandonment of Partial Conservation Technologies in Developing Economies: The Case of South Asia

Alwin D'Souza[a,*], Ashok K. Mishra[b]

[a] Graduate Student, Morrison School of Agribusiness, W.P. Carey School of Business, Arizona State University, Mesa, AZ, United States
[b] Kemper and Ethel Marley Foundation Chair, Morrison School of Agribusiness, W.P. Carey School of Business, Arizona State University, Mesa, AZ, United States

ARTICLE INFO

JEL classification:
Q2
Q33
D83

Keywords:
Partial conservation agriculture
Indo-Gangetic plain
Adoption
Abandonment
Social networks
Spouses

ABSTRACT

Conservation agriculture (CA), a resource saving production system, could increase marginal farmers' incomes and sustainable agricultural systems, but adoption of CA includes the adoption of multiple technologies in the form of a package. Consequently, a complete adoption of a package of full CA technologies could be costly in the developing countries. Alternatively, encouraging the adoption of a complete package of CA technologies, in some cases, partial adoption of selected CA technologies (or PCA) may be suitable for the developing countries. Using farm-level data this study investigates the factors affecting the adoption and abandonment of PCA in the Indo-Gangetic plains of India. Particular attention is given to the role of spouses and social networks in the adoption and abandonment decisions of PCA. Findings show that social networks have a significantly positive effect on the adoption, but a significantly negative effect on the abandonment of PCA. Additionally, spouse's involvement in agricultural activities has a significant effect on the adoption of PCA. Finally, we find that farmers who saw PCA in action and not just heard from their neighbors, were more likely to adopt and less likely to abandon PCA. Therefore, promotional events through audio and visual media may not be as effective in the adoption of PCA.

1. Introduction

On the one hand, Malthus, a 19th-century pastor, and scholar claimed in his "*An Essay on the Principle of Population*" that if population growth were not checked, it would grow exponentially while the resources would grow arithmetically, leading to food insecurity and social problems. This seemed to be true during the 1960s in South Asia when high population growth and food scarcity became a serious issue, particularly, during which India was on the brink of famine (Khush, 2001). On the other hand, Boserup (1975; Boserup (1975; 1981) concluded that population growth is exogenous and leads to more intensive use of agricultural land—increased cropping intensity.[1] Agricultural intensification was propelled by the use of high yielding varieties (HYV) of staples, along with the use of fertilizer and irrigation. As the adoption of HYV spread across South and Southeast Asian countries, productivity of rice, wheat, and maize rose significantly, along with increased use of labor, land, fertilizer, and pesticides. Also, the growing period for these crops became shorter, resulting in an increased scope for multiple cropping (Pinstrup-Anderson and Hazell, 1985). This phenomenon led to increased yields and profits for farmers, especially in South and Southeast Asian countries.

Such an achievement, however, came with significant costs. For instance, HYV crops required higher amounts of fertilizer and water; increased usage led to the over exploitation of water and soil resources—drastically lowering ground water-table and degrading soil fertility. This has been particularly true in areas of rice-wheat cropping systems (Byerlee and Siddiq, 1994; Hobbs and Morris, 1996; Rahman, 2003; Morris et al., 1994). Production of HYV of staples has rapidly depleted micronutrients from the soil and chemical fertilizers did not compensate for the losses of micronutrients. Five decades later, farmers in South Asia and India, in particular, are facing several problems, and the need for resource conservation is paramount. With falling yields, increasing energy prices, as well as higher fertilizer and input costs, agriculture in South Asia is becoming a costly proposition. This would

* Corresponding author.
E-mail addresses: adsouza3@asu.edu (A. D'Souza), ashok.k.mishra@asu.edu (A.K. Mishra).

[1] Boserup (1980) defines agricultural intensification in terms of cropping frequency. Boserup (1981) argues that pollution growth as a precondition for agricultural development because greater population density is required for adoption of land intensive techniques (e.g., HYV staples) to be economical.

http://dx.doi.org/10.1016/j.landusepol.2017.10.015
Received 4 July 2017; Received in revised form 6 October 2017; Accepted 9 October 2017

Table 1
Definition, adoption and abandonment of PCA technologies/practices, India, Nepal, and Bangladesh.
Source: http://csisa.org/resources/csisa-phase-i-baseline-data/ Accessed on 6 January 2016.

CA Technologies/practices	Definition	Adoption rate (%)	Abandonment (%)
Direct seeded rice (DSR)	Direct seeding of rice is the process of establishing rice crops directly rather than transplanting. DSR can reduce labor requirements by 50 compared to the traditional method (Santhi et al., 1998) and water usage by 35–57% (Singh et al., 2002a,b).	22.54	21.85
Zero tillage drill	This technology is attached to the small four wheel tractor to sow wheat directly to the unplowed field in a single pass. This drill makes 6–13 narrow slits for placing seeds and fertilizers at a depth of 7.5–10 cm. This technology would lead to a 19% increase in yield and cost savings of 6% of income (Keil et al., 2015).	11.21	8.08
Laser land leveling	This technology employs a laser controlled system to increase the precision of land leveling. Benefits: This can reduce usage of water, nutrients and agro-chemicals along with reducing labor during crop management. As a result, crop yield and quality of soil improves (Rickman, 2002)	6.51	2.20
Bed planting	Under this practice soil is tilled with rotating blades and then long beds are made which alternate with furrows. This method helps in weed control and increase the efficiency of water, fertilizer and labor usage and grain yield (Majeed et al., (2015).	10.36	4.22
Double no till	This approach means when both the crops in the system follows zero tillage. The soil properties improved under this approach along with improvement of water use efficiency and productivity (Jat et al., 2009).	0.21	0
Leaf color	This is used to measure the intensity of green color in rice leaves. This is to assess the nitrogen requirements and is being standardized with chlorophyll meter. Use of leaf color charts reduces the N requirements by 12.5–25% without impacting the yield (Singh et al., 2002a,b; Shukla et al, 2004).	1.92	0.73
Site specific – nutrient management	SSNM involves the following approach: indigenous nutrient supply at each site, temporal variability in plant N status occurring within one growing season, medium term changes in soil P and K supply based on the cumulative nutrient balance (Dobermann and Fairhurst, 2000). Increase in yield and fertilizer-N efficiency (Dobermann et al., 2002).	0.42	0
Relay cropping	This is a method of multiple cropping where one crop is seeded into standing second crop well before harvesting of the second crop. This can improve soil, air and water quality, increase net return and control the infestation of weed and pest. There have been evidences of higher crop yield through crop diversification (Tanveer et al., 2017).	10.57	2.02
Seed treatment	This approach entails application of biological, physical and chemical agents to the seeds to provide protection and improve the establishment of healthy crops. Treated seeds are more stress reliant and effective against pest attacks (Ramamoorthy et al., 2002; Ashraf and Foolad, 2005)	33.11	2.75
Turbo seeder	They can till, size residue and plant cover crops simultaneously. Usage of turbo seeder has led to reduction in fuel consumption and cost of crop establishment. It has also helped in enhancing the sowing date along with reducing the need for irrigation (Sidhu et al., 2015).	0.10	0
Residue retention	Retaining crop residues which are remains of previous crop including green manure cover crop has been reported to improve water infiltration, decrease water evaporation, enhance biological activity and reduce the growth of weeds (FAO, 2002)	52.58	0

have an adverse impact not only on the income of farmers but also poses a greater threat to food security of smallholder and marginal farmers.

Conservation Agriculture (CA)[2] is an agricultural system which has been claimed to be a resource-saving food production system aimed at intensification of production with high yields—termed as sustainable (Hobbs et al., 2008). Technologies about CA not only have the potential to lower input usage but also preserve the environment (Stevenson et al., 2014; Pannell, Llewellyn, and Corbeels, 2014). However, two studies published recently point out that the adoption of CA should be considered as a package, "*partial*" or "*full,*" as various components of CA tend to complement each other (Pannell, Llewellyn, and Corbeels, 2014; Kirkegaarda et al., 2014). Additionally, the authors note that adoption of CA as a "*full*" package is not practically feasible for smallholders in the developing economies of South Asia (India, Nepal and Bangladesh) given the financial, land, and risk related constraints faced by smallholders. We define "*partial*" as the adoption of one or more CA technologies/practices, rather than the "*full*" package (we use acronym PCA hereafter).

The literature on CA is extensive (mostly on the adoption of CA technology/practices, see Erenstein and Laxmi, 2008; Hobbs et al., 2008; Pretty et al., 2006; Wall, 2007), but it fails to offer insights on four key issues. Firstly, the literature falls short on the adoption and abandonment of PCA technologies/practices, especially in the context of developing economies, where HYV adoption was significant in the last five decades. Secondly, the literature fails to assess the role of social networks in the adoption and abandonment of PCA technologies/practices. Thirdly, the literature provides no evidence of the role of spouses in the adoption and abandonment decision of PCA technologies and finally, spatial nature of technology adoption, especially the decision to adopt and abandon PCA technologies/practices, is lacking.

This study intends to fill the above gaps in the literature by focusing on the adoption and abandonment of PCA technologies/practices. Therefore, the objective of this study is twofold: firstly, to investigate the factors influencing the adoption and abandonment of PCA technologies/practices. Table 1 describes PCA technologies/practices[3] that are examined in this study. Second, to assess the role of social networks and spouses in the adoption and abandonment of PCA technologies/practices. We use spatial estimation method and farm-level data from India, Bangladesh, and Nepal. The study contributes to the literature in several ways. First, the study will provide a better understanding of adoption and abandonment of PCA technologies/practices in the context of developing countries. Adoption of specific technologies in the form of PCA technologies/practices

[2] CA entails an enhancement of the natural resource base through three interrelated principles. These include: (1) permanent or semi-permanent soil cover through crop residues or crop covers; (2) minimal soil disturbance; (3) crop rotation (Hobbs et al. 2008; Abrol and Sangar, 2006). The CA or no tillage systems entails "loosely-coupled" farming systems with "tightly coupled components" (Coughenour, 2003).

[3] A multivariate probit method was to assess the possibility of complementarity in adoption decision of various CA technologies/practices and abandonment decision of CA technologies/practices, separately. For example, a multivariate probit model for three technologies (direct seeded rice (DSR), zero tillage drill (ZT) and bed planting was also estimated. Results are presented in Table A2. Results indicate complementarity in the adoption decision of technologies/practices and abandonment decision of CA technologies/practices.