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RESEARCH ARTICLE

Do Land Characteristics Affect Farmers' Soil Fertility Management?

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Abstract

Soil fertility management (SFM) has important implications for sustaining agricultural development and food self-sufficiency. Better understanding the determinants of farmers' SFM can be a great help to the adoption of effective SFM practices. Based on a dataset of 315 plots collected from a typical rice growing area of South China, this study applied statistical method and econometric models to examine the impacts of land characteristics on farmers' SFM practices at plot scale. Main results showed that in general land characteristics affected SFM behaviors. Securer land tenure arrangements facilitated effective practices of SFM through more diversified and more soil-friendly cropping pattern choices. Plot size significantly reduced the intensities of phosphorus and potassium fertilizer application. Given other factors, 1 ha increase in plot size might reduce 3.0 kg ha^{-1} P_2O_5 and 1.8 kg ha^{-1} K_2O. Plots far from the homestead were paid less attention in terms of both chemical fertilizers and manure applications. Besides, plots with better quality were put more efforts on management by applying more nitrogen and manure, and by planting green manure crops. Significant differences existed in SFM practices between the surveyed villages with different socio-economic conditions. The findings are expected to provide important references to the policy-making incentive for improving soil quality and crop productivity.

Key words: land characteristics, soil fertility management, farm household, rice cropping, South China

INTRODUCTION

Soil degradation on agricultural land has been viewed as a serious environmental and economic problem in many developing countries (Koning *et al*. 2001; Scherr and Yadav 2001; Sanchez 2002; Heerink 2005; Rasul and Thapa 2007; Ye and van Ranst 2009). In China, a resource-poor country with pressure of securing the huge population's food self-sufficiency, it is especially severe (Lindert 1999; Yang 2006; Guo *et al*. 2010). The goal of soil fertility management (SFM), which normally includes soil tillage, fertilization, irrigation, cropping systems and straw application, is to create good soil conditions for crop growing with high yield (Greenland and Nabhan 2001; Yang 2006). Since soil quality is fundamental for agricultural production, improving SFM is becoming increasingly crucial for policy-making with regard to food security, poverty reduction and environmental protection.

Although most SFM practices can facilitate higher yield in a short-term, their net effects on soil quality and thus on potential agricultural productivity can be very different in a long-term. Inappropriate SFM practices, such as long-term mono-cropping, overused/unbalanced application of chemical fertilizers, and lack of farm yard manure application, can accelerate land degradation and threaten the agricultural sustainability and environmental health (Zhen *et al*. 2006). Overused chemical nitrogen

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fertilizer has caused significant acidification in major Chinese croplands since the 1980s (Guo *et al*. 2010), which has been a serious challenge to food self-sufficiency in China. Effective SFM practices, such as balanced application of chemical fertilizers, crop rotation, crop straw recycling and manure application, have been proved to play a vital role in sustaining agriculture by building up soil organic matter (Moreno *et al*. 2006; Chen *et al*. 2009; Sombrero and de Benito 2010), and promoting soil and water conservation (Huang *et al*. 2008). Effective SFM practices have also been regarded as a cost-effective way of cooling down the earth and improving agricultural sustainability and environmental health (IPCC 2007). However, the effective SFM practices have not been popularly adopted by farmers worldwide till now (Li *et al*. 2011). Knowing which factors determine the adoption of SFM practices and how, can provide important references to the policy-making incentive for improving soil quality and crop productivity.

Socio-economic factors play an important role in farmer's decision-making for SFM practices. During the past decades, a lot of attention has been paid to examine the determinants of SFM practices. However, most existing studies have focused on bio-physical aspects. In fact, farmers make their decisions related to SFM not only based on the farmland natural conditions and technological availabilities, but also on socio-economic factors. Fortunately, research on socio-economic factors has drawn increasing interests from researchers during the past decades. For example, Katz (2000), Deininger and Jin (2003) argued that secure land tenure and appropriate land use policies could encourage farmers to better manage their soil by providing incentives. Omamo *et al*. (2002) explored the driving factors of small farms' SFM in Kenya, and found that lower farm-to-market transport cost, or larger quantity of family labor significantly encouraged chemical fertilizer application. Tittonell *et al*. (2010) examined the effects of rural livelihood strategies on SFM in Kenya and Uganda, and found that farm livelihood strategies significantly influenced the soil management practices through cropping pattern choices. The existing researches have greatly enhanced the understanding of socio-economic factors' influence on SFM practices.

Soil fertility is more related to specific plots, however, most available researches were performed at village or farmhouse scale. Thus, it is desirable to examine the impacts of land characteristics on farmers' SFM practices at plot scale, especially in South China where some typical SFM problems like paddy soil acidification and soil compaction broadly exist. Moreover, land is very seriously fragmented due to the prevailing system of land allocation and land reallocation in this area. According to Tan *et al*. (2006), cultivated land area per household was 0.61 ha in 1986, and it became 0.53 ha in 1999; farm households had on average 8.43 plots in 1986 and 6.06 plots in 1999. Land fragmentation in South China was severer. Data from the Rural Fixed Observation showed that each farm household had 8.95 plots, with plot size less than 0.05 ha in Jiangxi in 1999 (Tan *et al*. 2006). Furthermore, based on a survey from 17 provinces during 1999 to 2010, land has been reallocated in all the surveyed provinces. In Jiangxi Province, more than 90% of the sample villages had reallocated their land at least 4 times. Although land consolidation program has been launched in some provinces during the past 2 decades, reducing land fragmentation to some extent, cultivated land was still severely fragmented. In 2010, each household on average only had 0.41 ha cultivated land, spreading over 4.4 plots (Feng *et al*. 2011).

As an important characteristic, land transfer is becoming more and more popular in China (Ye *et al*. 2010; Gao *et al*. 2012; Qin and Tan 2013). In 2008, transfer took place on 8.17% of the total contracted land. It was 11% in 2009 and 20% in 2012. A study of Gao *et al*. (2012) showed that the cultivated land rental rate was 19% for the sample households, almost doubled that of in 2000 (10%). The share of households involved in land transfer was as high as 50% in the developed areas like Shanghai. Actually, land transfer was carried out by farmers at plot level. Land rental and other socio-economic characteristics have significant impacts on farmers' SMF strategies (Gao *et al*. 2012), and have implications for sustaining agricultural development and food security (Yu *et al*. 2003; Tittonell *et al*. 2007). However, detailed empirical research on how plot characteristics affect farmers' SFM strategies has not been fully understood.

Large uncertainties still remain on the impacts of plot factors on farmers' SFM strategies. Related studies are rare with a few exceptions such as Ali (1996), Sah *et al*. (2010) and several ones on China (Li *et al*. 1998; Yu *et al*. 2003; Gao *et al*. 2012). For example, Li *et al*. (1998) applied a dataset with 160 plots from 80 households, to examine the effects of land tenure on