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RESEARCH ARTICLE

Farmer behavior and perceptions to alternative scenarios in a highly intensive agricultural region, south central China

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Abstract

Intensive agriculture has caused unintended environmental consequences, such as water quality degradation. It is necessary for policymakers to make proper planning of sustainable agricultural development. Using a Pressure-State-Response (PSR) framework, we conducted surveys focused on farmer behavior toward agriculture and environmental protection in 2009 and 2011. The surveys indicated that farmer behavior was complex and contradictory, and caused some environmental effects. Therefore, we used normative landscape scenario method to develop two scenarios. Both scenarios emphasized on stable economic growth along with water quality improvement and presented good effects. A feedback survey was organized in 2013 to interpret farmers' perceptions of the alternative scenarios. The results indicate Scenario I is likely to be accepted by farmers; however, the beautiful rural landscape in Scenario II represents what farmers want, and Scenario I or II can be achieved by changing farm behavior in the future. By logistic regression model analysis, increasing agriculture benefits and new technology popularization were key factors affecting farmer behavior. Relevant policy implications on farmers were proposed. This paper showed how important to understand farmer behavior and perceptions to agricultural development, and a description of the alternative scenarios and policy implications are meaningful for policymakers to manage nature resources.

Keywords: farmer behavior, alternative scenarios, PSR framework, water quality

1. Introduction

Agricultural non-point source (NPS) pollution has been recognized as a major contributor to water quality degradation in highly intensive agricultural areas. NPS pollution from agricultural land use is a very complex problem. It continues to be a significant challenge to improve and protect water quality worldwide (Lam *et al*. 2011; Liu *et al*. 2013). Therefore, agricultural policies and farmland practices impact intensive agricultural land use, which in turn affects water quality, greenhouse gases, and biodiversity. Policymakers try to find effective policy instruments to alleviate water pollution or protect the environment (Wescoat and Johnston 2007; Blackstock *et al*. 2010; Stuart *et al*. 2014). These policies may limit some farmer behaviors, or encourage the farmer to adopt a new practice to mitigate water pollution. However, sometimes farmers do not respond to policies as expected (Sattler and Nagel 2010; Willy *et al*. 2014). The study of farmers' perceptions and decision-making behavior can play a significant role in the development of policies. Policymakers should greatly consider the farmer behavior

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and perceptions during the policy-making process.

Many conservation practices have been implemented for environmental protection, water quality, or biodiversity all over the world. To test the efficacy of these measures and recommend further scientific and stakeholder consultations, a review of farmer adoption decision behavior is necessary. Many empirical studies have been conducted to analyze the relationship between the adoption of conservation practices and farmers (Ryan *et al*. 2003; Lemke *et al*. 2010; Sattler and Nagel 2010), such as farmer's adoption of the Nitrate Reduction Programme in Greece (Giovanopoulou *et al*. 2011), the Rural Environment Protection Scheme in Ireland (Murphy *et al*. 2014), pesticide control in Vietnam (Hoai *et al*. 2011), and water quality trading in the U.S. (Mariola 2012). These conservation practices were proposed and examined by analyzing farmers' perceptions. Research about farmer attitudes and motivations has a more extensive application, such as farmers' perceptions about biodiversity (Malawska *et al*. 2014) and the abstract ecosystem services concept (Smith and Sullivan 2014).

In an effort to better address the different effects of agricultural policies and practices, the methods for understanding farmers' perceptions include: face-to-face interviews, interviews by e-mail, telephone and questionnaires by mail, and workshops. There are many farmer-specific variables to choose from, such as age, location, education, and income (Mbaga-Semgalawe and Folmer 2000). Ingram (2008) focused on a farmers' knowledge about soil and its sustainable management. Farmers' perceptions are complex, and can constantly change in the context of internal and external factors. Cross *et al*. (2011) showed how economic dependence is diminishing farmer motivation to participate in conservation programs, but Kvakkestad *et al*. (2015) found that income was less important than other factors for responders. Baumgart-Getz *et al*. (2012) provided a quantitative summary of 46 studies from 1982–2007 addressing the adoption of agricultural best management practices in the U.S. and found that farmer adoption decisions were always changing. Knowler and Bradshaw (2007) summarized a universal variable from the world's empirical studies, but Prokopy *et al*. (2008) concluded that there was no single factor that consistently affected farmer decisions. Statistical analysis is a common method for learning the relationship between farmers' perceptions and agricultural policies. Farmer typology and the neighborhood effect were also reviewed in some studies (Baerenklau 2005; Briggeman *et al*. 2007). From the literature reviews, a strong understanding of farmers' perceptions is very helpful in making and implementing policies, as well as choosing useful farmer-specific variables that may generate further information.

In China, the large population of farmer supplies more opportunities. There are lots of studies focusing on farmer behavior from different perspectives; for example, farmer attitudes toward China's Sloping Land Conversion Program (Grosjean and Kontoleon 2009; Komarek *et al*. 2014), and the Grain for Green Program (Cao *et al*. 2009; Liang *et al*. 2012). Especially in the primary production areas, agricultural intensification has caused many serious environmental problems. Managers are seeking to find effective policies and practices to balance agriculture and the environment. Farmers as direct operators play a significant role in the process (Zhen *et al*. 2011). Facing food security and environmental problems, a study of Chinese farmers' perceptions could provide useful information and set an example for developing countries.

Although the above comprehensive studies provide helpful insights about farmers for policy-making and environmental improvement, most of them only explain farmer attitudes, motivations or decision-making about one specific policy or practices, which is just one part of the process of policy-making. They often ignore farmer participation before policy-making or obtain feedback after policy implementation. Farmers' perceptions are very complex and can be affected by many factors at the same time, therefore continuous study is required.

To explore future agricultural environmental protection and guide relevant policy-making, we investigated farmers from 2009 to 2013. Based on the first two investigations, we understood farmer's behavior and assessed environmental effect. And using a normative landscape scenario method, we designed two scenarios to illustrate future agricultural land use with different water quality improvement. Then we discussed the farmers' perceptions to alternative scenarios and analyzed feasibility and acceptability of scenarios. With the help of logistic regression model, we found the key factors and proposed agricultural policy to change farmer's behavior and perceptions to meet the hypothetical scenarios. Farmers were involved in each process, including: target setting, design, and feedback. Both designing rules of alternative scenarios and a detailed analysis of farmer's behavior and perceptions could provide recommendations for policymakers.

2. Methodology

2.1. Study area

Jinjing Town (27°55′–28°40′ N, 112°56′–113°30′ E) (Fig. 1) is a primary grain-producing area located in Dongting Lake Basin in south central China. It covers approximately 13 440 ha, 65% woodland and approximately 27% arable farming land of the landscape. Double-cropped rice is the main crop. Jinjing is comprised of 14 villages and 2 communities. The population was approximately 42 000, and net