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Willingness of smallholder rubber farmers to participate in ecosystem protection: Effects of household wealth and environmental awareness

Shi Min[a,*], Junfei Bai[b], Jikun Huang[a], Hermann Waibel[c]

[a] China Center for Agricultural Policy, School of Advanced Agricultural Sciences, Peking University, No. 5 Yiheyuan Road, Haidian District, Beijing 100871, China
[b] College of Economics and Management, China Agricultural University, 17 Qinghua East Road, Haidian District, Beijing 100083, China
[c] Institute of Development and Agricultural Economics, Leibniz University Hannover, Gebäude 1503, Königsworther Platz 1, Hannover 30167, Germany

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ABSTRACT

The rapid expansion of natural rubber farming in southern China has led to negative environmental consequences, such as soil erosion and biodiversity loss. Therefore, local governments have made the restoration and protection of ecosystems a major policy issue. However, such efforts will only be successful if local communities participate. Using cross-sectional data on 612 smallholder rubber farmers in Xishuangbanna, this study investigates the willingness of smallholder rubber farmers to participate in ecosystem protection. We employ a multivariate probit regression model to estimate three ways of participating in environmental protection: (i) through monetary contributions of rubber farmers, (ii) by reducing rubber areas, and (iii) through the provision of free labor. The results show that most rubber farmers are willing to participate in local ecosystem protection. While wealthier households tend to participate by contributing money and providing free labor, poorer households prefer to reduce their rubber planting areas. Approximately 10% of the farmers believe that rubber cultivation has positive environmental effects and therefore abstain from participating in ecosystem protection measures. Our findings have important implications for policymakers who want to implement programs to restore and protect ecosystems in Xishuangbanna and other rubber planting regions in southern China.

1. Introduction

With the increasing expansion of natural rubber (*Heveabrasiliensis*) farming in the Mekong region, including Xishuangbanna Dai Autonomous Prefecture (XSBN) of southwestern China (Fu et al., 2009a), the controversy related to its sustainability has intensified in recent years (Qiu, 2009). Natural rubber is one of the very few industrial raw materials to be produced with a beneficial economic and environmental impact (Diaby et al., 2013). On the one hand, rubber cultivation has significantly improved the livelihood of smallholders (Guo et al., 2002; Liu et al., 2006; Fu et al., 2009b; Herrmann and Fox, 2014; Min et al., 2017a). On the other hand, the rapid expansion of smallholder rubber farming, most of which is grown in monoculture (Fox et al., 2014), has triggered the loss of virgin forest and has caused ecological degradation (Xu, 2006; Zhang et al., 2007). At present, the negative effects of rubber farming on local ecosystems, including decreasing biodiversity and soil erosion, are widely recognized by scholars and policymakers (Liu et al., 2006; Xu, 2006; Hu et al., 2008; Fu et al., 2010; Yi et al., 2014). Restoring and protecting the local ecosystems that are threatened by rubber farming have become urgent issues.

In the context of the "New Normal Theory", which was outlined by Chinese President Xi Jinping in 2014, government authorities have emphasized that agricultural development must be environmentally friendly and conducive to the conservation of ecological conditions (Chen, 2015). The local government of XSBN aims to restore and protect local ecosystems by promoting sustainable rubber cultivation. According to the twelfth five-year plan generated by XSBN's biological industry office, approximately 500,000 mu[1] of low-productivity and high-altitude rubber plantations should have been transformed from rubber production into more sustainable land use by 2015. The "Environment-Friendly Rubber Plantation" program, which was proposed in 2009, has been gradually implemented by the local government. The main components of this program are the reduction of rubber plantations on unsuitable land and the establishment of a rubber-based agroforestry system (Xiao et al., 2014; Zhang, 2015). Moreover, the natural rubber eco-certification recognized as the path with least resistance has also been proposed to improve the sustainability of rubber plantation (Kennedy et al., 2017). However, as of now, the adoption of natural rubber eco-certification is few and with little attention in XSBN.

Most previous studies on the implementation of environmental

* Corresponding author.
E-mail address: min.ccap@pku.edu.cn (S. Min).
[1] 15 mu = 1 ha.

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conservation policy tend to investigate farmers' participation willingness under Payments for Ecosystem Services (PES) themes (Yin et al., 2013; Pan et al., 2017). Given the significant contribution of natural forests through ecosystem services (Reed et al., 2017), PES themes have attracted broad international attention as a novel approach of using economic incentives to mitigate deforestation, forest degradation, and biodiversity loss (Yin et al., 2013; Phan et al., 2017). The rapid emergence of PES in China has also been reported widely (Guo et al., 2014; Pan et al., 2017). However, according to the polluter pays principle (Palmer, 1998; He et al., 2012), smallholder rubber farmers also need to pay for the negative environmental consequences of rubber cultivation. Thus, under the theme of PES, the decision on using economic incentives to encourage smallholder rubber farmers to protect ecosystem threatened by rubber farming should be made carefully. Wallander et al. (2017) indicated that voluntary land conservation programs depend upon the willingness of land owners to participate, while the study of Khanal et al. (2017) found that some landowners in USA would participate in carbon sequestration even with little or no incentive. Thus, a question is raised whether smallholder rubber farmers are willing to participate in ecosystem protection without any economic incentive, which can provide useful information for the design of future payment schemes (Mislimshoeva et al., 2013).

For sustainable rubber cultivation policies to succeed, the participation of smallholder rubber farmers is essential. In XSBN, > 50% of rubber plantations, accounting for nearly all of the rubber planted in ecologically sensitive land areas, are operated by local smallholders. Currently, smallholders' attitudes toward environmental protection remain unclear. While there are numerous studies on the participation of individuals in environmental conservation programs (Flores and Carson, 1997; Vanslembrouck et al., 2002; Cooper, 2003; Torgler and Garcia-Valiñas, 2007; Ma et al., 2012; Lankia et al., 2014), to our knowledge, no such study exists related to rubber. Existing studies have analyzed the willingness to pay (WTP) for the preservation of original landscapes and indigenous species among urban residents of XSBN (Ahlheim et al., 2013, 2015) and Shanghai (Ahlheim et al., 2014).

The objectives of this research are the following: (i) to assess the willingness of smallholder rubber farmers to participate in ecosystem protection measures and (ii) to examine the roles of household wealth and environmental awareness in the farmers' participation. Hereby, we investigate three possible ways for smallholders to contribute, namely, by reducing the size of their rubber plantation areas, by making voluntary financial contributions and by providing free labor for implementing ecosystem protection measures. Based on cross-sectional data collected from 612 smallholder rubber farmers in Xishuangbanna in 2013, we estimate a simultaneous equation model to account for the likely correlation between the three ways of farmers' participation.

Our main findings are that farmers' awareness of environmental problems determines their willingness to participate in environmental programs. Although most smallholder rubber farmers are willing to participate in local ecosystem protection, wealthier households prefer to participate by contributing money and labor, while poorer households are more willing to reduce their rubber areas.

This paper is organized as follows. In the next section, we present the theoretical framework and our hypotheses. In section three, we introduce the circumstances of the study region and the data collection procedure. We also present basic statistics on smallholder rubber farmers' household wealth, environmental awareness, and willingness to participate in ecosystem protection. In section four, we develop econometric models to estimate smallholders' willingness to participate in ecosystem protection and empirically test the hypotheses. In section five, we present and discuss the results, focusing on the effects of household wealth and environmental awareness. The final section concludes the paper and discusses several policy implications.

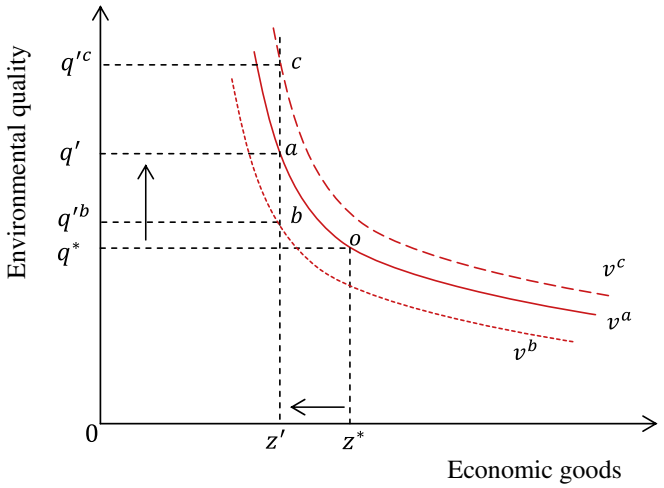

Fig. 1. Consumption trade-offs between economic goods and environmental quality.

2. Theoretical framework and hypotheses

A farmer's willingness to participate in environmental protection measures can be modeled by means of a utility maximization framework that combines the consumption of market goods and non-market environmental services (Vanslembrouck et al., 2002; Dupraz et al., 2003; Plassmann and Khanna, 2006; Ma et al., 2012). The corresponding trade-offs can be illustrated by an indifference curve analysis (Hicks and Allen, 1934; Israel and Levinson, 2004). Inspired by previous studies, in this section, we first discuss the trade-offs between the consumption of economic goods and the improvement of environmental quality when an environmental program has been introduced. Second, by incorporating a farmer's producer and consumer behaviors, we attempt to derive a conceptual model that determines the willingness of smallholder rubber farmers to participate in ecosystem protection measures. We present two central hypotheses in the following section.

2.1. Indifference curve analysis

In Fig. 1, we illustrate the usual trade-off between economic and environmental goods for a defined level of utility. We suppose that o is the initial optimal point at which a smallholder rubber farmer maximizes utility, subject to certain budget constraints and exogenously fixed environmental quality. The optimal consumption of economic goods is z^*, while v^a is the indifference curve. Farmer participation in an environmental program may require farmers to forgo a certain amount of economic goods, which is denoted in Fig. 1 as the move from z^* to z'. The equivalent environmental improvement is shown as the move from q^* to q', which will maintain the level of utility v^a.

However, farmers with different attributes, x, are likely to have heterogeneous expectations about their participation in an environmental program. First, if a farmer anticipates that her participation can only increase the environmental quality to q'^b, the new optimal choice will be the point b at which the farmer achieves the new maximum utility v^b. Compared with the initial point o, the increased utility of improved environmental quality cannot fully substitute for the utility loss of the reduced economic goods, and hence the utility v^b is less than the initial utility v^a. In such a case, the farmer would not be willing to participate in the environmental protection program. Second, if the farmer expects that the environmental quality can reach q'^c, the optimal