Farmers' pesticide use behavior toward own consumption- versus sale-oriented production: Joint effects of risk preferences and perceptions of health risks

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Introduction

Crop pests negatively affect food security and farmer incomes, while chemical pesticide use affects the environment and farmer and consumer health, especially in developing countries (Ekström and Ekbom, 2011; Hossain et al., 2004; Pretty, 2005). Relying on a unique set of survey data collected in 2014 in Cambodia, Vietnam, and China, this comparative research aims to examine how smallholder farmers' pesticide use behavior differs in own consumption- versus market sale-orientated production and how risk preferences and perceptions of health risks jointly affect pesticide and other input use.

The study include sties from three Asian countries, Cambodia, Vietnam and China, where many aspects of pesticide practices, regulations, and access to information regarding the health and environmental risks of pesticides differ. This region has enjoyed vibrant economic growth in the past few decades, but rapid growth in food production has placed a toll on its natural resource base with environmental stress increasingly limiting further growth in productivity and quality of life. Intensive, and often indiscriminate, use of pesticides is widespread in many parts of China and Vietnam and is rapidly rising in Cambodia. Given the rising economic, environmental and public health significance of pesticide use in the region, understanding the drivers of pesticide use behavior is essential for moving toward sustainable intensification and food security, while minimizing agricultural externalities.

Farmers' risk preferences play an important role in agricultural production decisions (Feder, 1980; Just and Zilberman, 1983). For profit-maximizing farmers, pesticides are a risk-reducing input; therefore more risk averse farmers are often found to use more pesticides. Looking to farmer behavioral characteristics, Liu and Huang (2013) demonstrate that higher pesticide use is characteristic of risk-averse farmers who are wary of crop failure, while lower

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pesticide use characterizes loss-averse farmers who are wary of health concerns. Pesticide use can impose health risks to both producers and consumers (Antle and Pingali 1994, Crissman et al. 1994, Dung, et al. 1999, Pingali et al. 1994), therefore, perceptions of such health risks are also expected to influence farmers' pesticide use behavior. We investigate perceptions of pesticide-related health risks along multiple dimensions, including farmers' awareness of the hazardousness of pesticides for farmers and their families, past experience with acute pesticide poisoning, application decision-making and practices (e.g., wearing protective clothing, choosing pesticide products and application doses), disposal and storage (e.g., location, method and disposal of used containers), and households' motivations for maintaining a home garden. One might expect more health-conscious farmers to use less pesticide. However, this effect may be further complicated by farmers' general attitude toward production- or health-related risks, as pesticide use is also tied to the risk of crop damage or failure. Therefore, it is essential to consider the interaction between farmers' risk preferences and perceptions of health risks when investigating farmers' pesticide use behavior, and more generally, input use in crop production.

When farmers make decisions on pesticide use in production of food for own consumption, the effects of pesticide use on profitability, producer health risk, and consumer health risk are all relevant. For production oriented for market sale, effects on consumers' health risk may be overlooked or carry less weight due to information asymmetry and lack of effective regulation – a feedback may not exist back to the marketability of the farmer's production, and the link to the farmer's own health is broken. This poses a potential moral hazard problem, in which farmers practice more intensive pesticide applications in crops used for sale than those used for own consumption. Anecdotally, it has been repeatedly observed in China that farmers do not spray or spray significantly less on home garden crops primarily intended for households'

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own consumption. Such differences in farmers' pesticide practices are likely influenced by considerations for profitability, producer health risk, and consumer health risks. Our analysis will tease out the impact of each factor and identify the presence and effect of the moral hazard problem on pesticide use behavior, accounting for the joint effect of farmers' risk preferences and perceptions of health risks.

Methods

Site selection and the sampling of villages across the sites followed a sampling framework established for an accompanying ecological field experiment that aimed to study insect activities across a range of agricultural landscapes classified by the level of land use complexity (presence of non-managed features and cropping diversity) into categories of Low, Medium, and High. Households were randomly selected from each selected village. Our sample is not representative at any administrative level, but could be considered a quota sample of farms with access to different levels of available ecosystem service associated with land use diversity in the landscape.

The sample includes 512 households in each of Cambodia and Vietnam and 320 households from China. In the household survey, we collected detailed plot-level farm management and production data by crop for each household. Additionally, we surveyed farmers' knowledge about biological pest control services, decision-making regarding pesticide application, awareness of and experience with pesticide poisoning, general practices in storage and disposal of pesticide containers, and the households' motivation for keeping a home garden. Following Tanaka, et al. (2010), we conducted a risk preference experiment to measure farmers' risk preferences by offering respondents a series of pair-wise lotteries of both risky and safe

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options, which elicit three risk preference parameters: risk aversion, loss aversion, and nonlinear probability weighting. The payout values used in the pair-wise lotteries in each country were pre-calibrated to local daily wage based on purchasing power parity (PPP). This allows us to uniquely identify the value function curvature and probability weighting parameters.

For our empirical strategy, we estimate two models. Model 1 follows Liu and Huang (2013) and estimates the determinants of pesticide use in plots cultivated primarily for own consumption and for market sale separately, incorporating risk parameters (risk aversion, loss aversion, and nonlinear probability weighting) and variables on knowledge of pesticide use and consequences and controlling for household-plot characteristics and village fixed effects to capture market conditions. Note that we cannot have a household fixed effects as the risk and knowledge variables are all at household level. In Model 2, we estimate the moral hazard effect on household-plot level pesticide use, using two specifications both of which consider household-plot characteristics. In the first specification, we incorporate household fixed effects and a continuous variable capturing the share of plot output used for own consumption vs. sale. In the second specification, we incorporate village fixed effects, in addition to the household-level risk and knowledge variables. To allow for moral hazard effect to vary with farmers' risk preferences and knowledge levels, we add interaction terms between variables for the risk preference and knowledge and those that capture the use of plot outputs.

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