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Farm types and farmer motivations to adapt: Implications for design of sustainable agricultural interventions in the rubber plantations of South West China

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ABSTRACT

Tropical land use is one of the leading causes of global environmental change. Sustainable agricultural development aims to reduce the negative environmental impacts of tropical land use whilst enhancing the well-being of the smallholder farmers residing in those areas. Interventions with this goal are typically designed by scientists educated in the Western tradition, and often achieve lower than desired uptake by smallholder farmers. We build on work done in farm type classification and studies of factors that influence adaptation, trialling a suite of household survey questions to elucidate the motivational factors that influence a farmer's willingness to adapt to external change. Based on a sample of 1015 households in the rubber growing region of Xishuangbanna, South-west China, we found that farm types based on structural characteristics (e.g. crops, livelihoods) could not be used to accurately predict farmers' motivations to adapt. Amongst all six farm types identified, the full range of motivational typologies was found. We found six motivational types, from most to least likely to adapt, named: Aspirational Innovators, Conscientious, Copy Cats, Incentive-centric, Well Settled, and Change Resistant. These groups roughly corresponded with those identified in literature regarding diffusion of innovations, but such classifications are rarely used in development literature. We predict that only one third of the population would be potentially willing to trial a new intervention, and recommend that those sectors of the population should be identified and preferentially targeted by development programs. Such an approach requires validation that these motivational typologies accurately predict real behaviour – perhaps through a panel survey approach. Dedicated data gathering is required, beyond what is usually carried out for ex-ante farm typologies, but with some refinements of the methodology presented here the process need not be onerous. An improved suite of questions to appraise farmers' motivations might include value orientations, life satisfaction, and responses to various scenarios, all phrased to be locally appropriate, with a scoring system that uses the full range of potential scores and a minimum of follow up and peripheral questions.

1. Introduction

Tropical land use for the past century has been dominated by conversion of forested lands to agricultural land, leading to loss of biodiversity (Barnes et al., 2014; Gibson et al., 2011), increased carbon emissions (Houghton et al., 2012; Le Quéré et al., 2014), changes in evapotranspiration patterns (Lawrence and Vandecar, 2015; Zhang et al., 2016), and the degradation of ecosystem services (Foley et al., 2005; Power, 2010). Proposed solutions tend to focus on the potential benefits that solutions could bring (e.g. Foley et al., 2011) or on evaluating the trade-offs in selecting one solution over another (Phalan et al., 2011). However, in most situations the decision to adapt one's behaviour is not taken by

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experts, but by smallholder farmers. In a recent review, enhanced adoption of sustainable agricultural interventions was linked to three features of projects: a fine-scale understanding of local needs, appropriate market and service mechanisms, and engaging adopters through the research process (Coe et al., 2014). These are particularly salient in situations of decentralised decision making, as occurs where many smallholder farmers are responsible for a mosaic landscape (Fox and Castella, 2013), which is the case across much of the tropics.

Rubber plantations in montane south east Asia have expanded leading to rapid replacement of diverse landscapes with monocultures, and giving rise to serious concerns about forest loss, ecosystem degradation, biodiversity loss and risky over-specialisation of livelihoods (Ahrends et al., 2015; Fox et al., 2014; Warren-Thomas et al., 2015; Ziegler et al., 2009). Scientific literature to date generally has focused on either potential management interventions (De Blécourt et al., 2014; Fu et al., 2010; Liu et al., 2015; Riedel et al., 2012; Thongyou, 2014; Viswanathan and Shivakoti, 2008), or potential policy interventions (Cotter et al., 2014; Smajgl et al., 2015b; Yi et al., 2014b). The efficacy of policy interventions is however determined by the interaction between policy mechanisms and the grass-roots responses (Smajgl et al., 2015a), therefore understanding the motivations of smallholder farmers to adapt their practices is essential in designing appropriate interventions.

Farm typologies are one method for understanding how different segments of a farming population might react to proposed interventions. Farm typologies are typically based on observable structural characteristics such as farm size, household size, crops grown, livestock raised, and incomes. These farm typologies are useful in determining which interventions are appropriate to specific types of farm and form the basis for many ex-ante intervention and prioritization analyses (Bongers et al., 2015; Herrero et al., 2014; Rufino et al., 2013; van Ittersum et al., 2008). The structural characteristics of a farm do not present the whole picture, however, and there is a temptation to use the structural characteristics to calculate the most efficient path to intensified production which disregards the system complexities that farmers deal with in their daily lives (van der Ploeg et al., 2009). Van der Ploeg et al. (2009) found that consideration of the balance of livelihood activities and farmers' objectives can help to explain the plurality of farm styles, when considered in combination with the farm structural characteristics. Indeed, the diversity of farmers' characteristics can render interventions which try to address the 'average farmer' redundant (Marshall and Smajgl, 2013). Targeting interventions according to farmers' motivations may be a more fruitful approach: for example farmers with conservation oriented attitudes are correlated with a higher willingness to adapt practices in a way which enhances conservation goals, and that those farmers who are strongly economically oriented require financial incentives in order to adapt (Greiner et al., 2009). Meijer et al. (2014) categorised factors influencing farmer motivations into 'extrinsic' and 'intrinsic' factors, where extrinsic are demographic, economic, geographical, and intrinsic are related to knowledge, perceptions, attitudes; and found that intrinsic factors in particular are often overlooked (Meijer et al., 2014). The goal of the present study was, therefore, to improve understanding of the relationship between the 'structurally' oriented farm types, and the different groups of factors which motivate farmers to adapt their behaviour. We posit that farmers' willingness to adapt is key to adopting new practices, and that understanding the farmers' motivations to adapt is therefore key to increasing adoption rates. From household survey data, we constructed one typology based on farm structural characteristics and livelihoods, and constructed a separate typology based on farmer motivations to adapt. We then assessed the linkages between the two groupings, and drew out the implications for design of agricultural interventions with a higher adoption potential.

2. Methods

Xishuangbanna is an autonomous prefecture of about 19,000 km^2 in Yunnan province, southwest China. Together with Hainan island, it is the only area of sub-tropical forest inside China's borders. The average temperature in Xishuangbanna is 20–22.5 °C, with an average high temperature of 25–27 °C occurring in May–June. Average precipitation is 1200–1800 mm per year and the wet season lasts from May to October during which 90% of the rain falls. The terrain is densely undulating, land elevation ranges from 400 to 2400 m above sea level, and there are four bio-climatic zones: warm temperate and moderately moist (high elevations); hot and moderately moist; extremely hot and moderately moist; and extremely hot and moist (low elevations) (Zomer et al., 2014). The primary crops are rubber, tea, and rice.

Xishuangbanna was originally heavily forested. In 1976 forests accounted for about 70% of land mass (Li et al., 2006). There has been a trend of deforestation since then. Accurate figures on deforestation are difficult to acquire from official governmental sources. However, two systematic studies of satellite imagery between 1976 and 2003 (Li et al., 2009, 2007) found that by 2003 forest cover in Xishuangbanna shrank from 69% to <50% of the landscape; that the important tropical seasonal rainforest shrank from 10.9% to 3.6%. There has been no systematic study of forest area since 2003; but we may infer that deforestation has increased, as the amount of land planted with rubber almost tripled between 2002 and 2010, from 153,000 ha to 424,000 ha (Xu et al., 2014).

Household survey data was gathered in a single campaign during 2010, in 50 villages, amongst two counties within the province of Xishuangbanna, South West China (Table 1). One thousand and fifteen households were interviewed. Villages were selected in discussion with government officials to cover the full altitude gradient of the rubber growing region, distributed across seven townships where rubber cultivation is prevalent. Three or four village committees were selected per township, and then two natural villages per village committee, making a total of 50 villages. Households were then selected at random from the government village register.

Altitude varied amongst the surveyed villages from 500 m above sea level to 1600 m. This altitude range strongly affects the viability of certain crops (rubber, coffee, tea); different ethnic groups tend to inhabit specific locations which can be defined by altitude; and altitude can also be seen as a rough proxy for development, where the communities at lower altitudes tend to have more developed educational, transport and market infrastructure.

The survey consisted of a ten-page printed questionnaire which took approximately one and a half hours to complete and was implemented in Mandarin Chinese. The survey was written by Smajgl and Ward (co-authors to this manuscript), and has been described elsewhere (Hassenforder et al., 2015; Smajgl et al., 2015b, 2016, Smajgl and Ward, 2015, 2013). The main topics covered were household demographics, ownership of assets including land, livelihood activities and incomes, personal value orientations, attitudes, perceptions of the likelihood of future events, and stated intentions to adapt under four hypothetical scenarios.

Household demographics included questions on family size, education, location, and ethnicity. Assets included farm size and land uses, as well as vehicles, machinery, and domestic appliances. The livelihoods section included crop and livestock yields and incomes, off-farm incomes, and non-cash gifts. Together, the data on household demographics, assets, and livelihoods are referred to from here on as 'farm characteristics'.

Table 1
Sampling structure of the households surveyed within Xishuangbanna.

County	Townships	Village committees	Natural villages	Households
Jinghong	3	12	24	486
Mengla	4	13	26	529
Total	7	25	50	1015

Jurisdictional levels within the province of Xishuangbanna are county, township, village committee (a group of villages represented by a common government committee), and finally natural villages (normal villages – a group of houses located close to one another).