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Research article

Climate change adaptation options in rainfed upland cropping systems in the wet tropics: A case study of smallholder farms in North-West Cambodia

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ABSTRACT

While climate change is confirmed to have serious impacts on agricultural production in many regions worldwide, researchers have proposed various measures that farmers can apply to cope with and adapt to those changes. However, it is often the case that not every adaptation measure would be practical and adoptable in a specific region. Farmers may have their own ways of managing and adapting to climate change that need to be taken into account when considering interventions. This study aimed to engage with farmers to: (1) better understand small-holder knowledge, attitudes and practices in relation to perceived or expected climate change; and (2) document cropping practices, climate change perceptions, constraints to crop production, and coping and adaptation options with existing climate variability and expected climate change. This study was conducted in 2015 in Sala Krau village near Pailin (12°52′N, 102°45′E) and Samlout (12°39′N, 102°36′E) of North-West Cambodia. The methods used were a combination of focus group discussions and one-on-one interviews where 132 farming households were randomly selected. We found that farmers were conscious of changes in climate over recent years, and had a good understanding of likely future changes. While farmers are aware of some practices that can be modified to minimize risk and cope with anticipated changes, they are reluctant to apply them. Furthermore; there are no government agricultural extension services provided at the village level and farmers have relied on each other and other actors in the value chain network for information to support their decision-making. There is a lack of knowledge of the principles of conservation agriculture that urgently require agricultural extension services in the region to build farmer ability to better cope and adapt to climate change.

1. Introduction

Climate change is already having serious impacts on agriculture in many regions worldwide (Fosu-Mensah et al., 2012; Mpandeli et al., 2015; Roland Azibo and Buchenrieder, 2014; Wood and Mendelsohn, 2015). Agriculture is highly sensitive to climate variability and climate change, and Ray et al. (2015) confirmed at least 60% of global crop yields (i.e. maize, soybean, rice and wheat) were explained by climate variability. Climate impacts are greater in developing countries whose economies rely heavily on agriculture (Morton, 2007). A study by Yusuf and Francisco (2009) showed that Cambodia is one of the countries in South-East Asia most vulnerable to climate change.

North-West (NW) Cambodia is an important production area for upland crops such as cassava, maize, mungbean, peanut and soybean. Agriculture is the economic backbone for the rainfed uplands of NW Cambodia where more than 80% of family income is from crop production (Brown and Johnstone, 2012). Short-term annual rainfall records (2006–2013) for Pailin (12°52′N, 102°45′E) and Samlout (12°39′N, 102°36′E) indicate slight upward trends with high variations from year to year. Future climate projections for Pailin and Samlout in NW Cambodia show a slight increase in

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annual rainfall with variations between years (Touch et al., unpublished). The projections have shown a trend for wetter conditions in the wet season, a later beginning and a later finish to the wet season. The mean temperature projections under RCP4.5 (intermediate emissions scenario) and RCP8.5 (high emissions scenario) are for warming per decade by 0.1 °C and 0.2 °C, respectively (Touch et al., unpublished). Farmers usually attempt to plant crops after occasional storms in the late dry season (February–March). Crop simulation modelling has shown that crops sown at these times are at high risk of crop failure; around 59% at Pailin and 32% at Samlout (Touch et al., unpublished). Another factor discovered from the modelling study is that soil nutrient depletion is an important factor limiting crop yield in the study areas. The study suggested that the risks of crop failure and profit losses can be minimized by adjusting sowing time, fertiliser application and crop rotations (Touch et al., unpublished).

Farmers will need to adapt their cropping systems to maintain yields and minimize vulnerability under climate change. This is called "agricultural adaptation to climate change" which often involves how climate change is perceived and followed by various responsive actions to those perceptions (Fosu-Mensah et al., 2012). Farmers from a specific region may have perception and responsive actions to climate change that are different to farmers in other regions. Socio-economic characteristics, knowledge and environmental factors influence perceptions of and adaptation to climate change (Deressa et al., 2011). Thus, this study aimed to engage with farmers to better understand small-holder knowledge, attitudes and practices in relation to perceived or expected climate change. Specifically, the study aimed to document cropping practices, climate change perceptions, constraints to crop production, and coping and adaptation options with existing climate variability and expected climate change.

2. Materials and methods

2.1. Descriptions of study sites

The study was conducted in early 2015 in Sala Krau village near Pailin (12°52′N, 102°45′E) and Samlout (12°39′N, 102°36′E) of NW Cambodia (Fig. 1). Climate conditions of Pailin, Samlout and Battambang are affected by the South East Asia Monsoon (SEAM, Chhinh and Millington, 2015). There is a five-month dry season (December–April) and a seven-month wet season from the onset of the SEAM between May and November. Four seasons based on rainfall and temperature can be defined:

1. Early Wet Season (EWS), May–July (warm and wet);
2. Late Wet Season (LWS), August–October (cool and wet);
3. Early Dry Season (EDS), November–January (cool and dry); and
4. Late Dry Season (LDS), February–April (warm and dry).

2.2. Data collection

A subset of 132 farming households were randomly selected from the 390 who took part in a previous survey in 2013 (Touch et al., 2016). Selection of locations and participants was on the basis of families growing upland crops as their main source of income, and respondents were randomly selected from the records kept by Village Chiefs. The study methods used were a combination of focus group discussions and one-on-one interviews. Topics discussed and interview questionnaires covered cropping systems and practices, changes in crops grown and sowing times, perceptions about soil fertility, constraints to farming production, and perceptions about temperature and rainfall patterns, followed by respondents' proposed actions in response to constraints.

Initially, participants were asked in small groups to discuss a range of topics. Each group comprised 6–8 individuals with two moderators to facilitate the discussions. The moderator roles were to introduce topics of discussion, encourage participants to express their viewpoints, listen carefully to participant comments and subtly keep discussions focused on the topic. The moderators also ensured an open, comfortable and interactive atmosphere during the discussions.

After the group discussions, face-to-face interviews were conducted on a one-to-one basis using a semi-structured questionnaire. The interviews were classified into (1) in-depth interviews and (2) standard interviews. The questionnaires used in the in-depth and standard interviews were almost the same. However, the In-Depth Interviews required more time, deeper discussions and a few more follow-up questions arising from the group discussions. Of the 132 participants, 30 who had been actively involved in the group discussions and were willing to spend more time were selected for the In-Depth Interviews. The main criteria and parameters for selecting the 30 participants were: (1) extensive experience in rainfed upland cropping systems, (2) involved in making decisions on the implementation of farming operations; (3) lived in the region for at least 10 years; and (4) willing to share and actively discuss farming related matters.

3. Results

3.1. Crop production

3.1.1. Distribution of crops grown and sowing times

The participants were asked about the crops they grew and sowing times over the past (2006–10), currently (2014–15) and what they expected in the future (for the next 30 years) (Table 1). Depending on seasonal conditions, it is possible to grow two crops per year including combinations of maize, soybean, mungbean, peanut and sesame, while one crop only per year is possible for cassava. At Sala Krau village (near Pailin), the first crops are usually planted in February–March and the second crops are usually planted in July–August. Farmers said they did not intend to change current sowing times and did not propose to change sowing times over the next 30 years. At Samlout, first crops such as maize, cassava and peanut were planted in March–April, and mungbean and sesame planted in January–March. The second crops (with sowing times in brackets) were maize (July–August), soybean (July) and mungbean (August–September). Similarly to Sala Krau, Samlout farmers did not intend to change their sowing dates then or in the future.

Farmers mentioned that they often had to replant the first crop at least twice after failures caused by hot and dry conditions in the LDS (February–March).

In the past (before 2010), crop diversity was greater, especially with inclusion of legumes (soybean, mungbean, peanut) (Fig. 2). However, by 2014–15, crop diversity had declined dramatically where cassava had become the predominant crop in both locations. Over the next 30 years, cassava and fruit trees were expected by farmers to be the most commonly grown crops in Sala Krau, while cassava was the only crop expected to be grown by most farmers in Samlout.

Farmers considered maize to have similar good drought resistance to mungbean, sesame, peanut and soybean, and it was relatively free of diseases and insect pests. In addition, intensive rain during the reproductive stage would not cause significant effects on yield quantity and quality because most maize varieties had good husk protection. However, the crop became a less popular choice with many farmers because profitability had declined over recent