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Why do farmers abandon jatropha cultivation? The case of Chiapas, Mexico

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ABSTRACT

The biofuel crop *Jatropha curcas* has been promoted in developing countries as a means of improving the livelihoods of rural populations. In Mexico, despite the initially assumed economic, environmental, and social benefits of the crop, many farmers have abandoned jatropha cultivation. Here, we analyse the factors that influence farmers' decision to abandon jatropha cultivation by using a generalized linear modelling approach in combination with qualitative research methods. The deterioration in perception of jatropha profitability, the non-payment of expected subsidies and the wealth position of the household played a major role in determining abandonment. The perception of pest and disease damage, although stated by farmers as the second most frequent reason to disadopt, was not correlated with this decision in the generalized linear model. This research might help energy policy makers in identifying key elements to prevent failure of promotion programmes. The result of this study also may be useful for an international audience to reflect on the appropriateness of promoting a new crop at the farmer level before realistically evaluating the economic viability of its cultivation.

Introduction

Jatropha (*Jatropha curcas* L.) has been intensively promoted as a potential renewable energy source for tropical areas worldwide. During the last decade, numerous jatropha projects have been implemented in Asia, Africa and Latin America (GEXSI, 2008; van Eijck et al., 2014a). The objectives of these projects have been diverse but promoting sustainable rural development, reducing energy dependency and greenhouse gases emissions have been frequent aims.

Recently, doubts have been cast on the profitability of jatropha and the financial viability of its cultivation (Valdés-Rodríguez et al., 2014; Eijck et al., 2014b). The unexpected low yield and low price for the seed, the limited valorisation of by-products (van Eijck et al., 2014a), and the underestimated labour and maintenance costs of fields (von Maltitz et al., 2014) have been the main drivers of this concern. Thus, the implementation of new jatropha projects has slowed down and several on-going initiatives have even ceased their activities (van Eijck et al., 2014a; Ahmed et al., 2017).

Many smallholder-based projects have promoted the cultivation of jatropha on land owned by farmers in order to improve their livelihood conditions. The motivation and enabling factors leading farmers to adopt jatropha as a new livelihood strategy have been studied in Africa (Basinger et al., 2012; Mogaka et al., 2014; Mponela et al., 2011), Asia (Ariza-Montobbio and Lele, 2010; Goswami and Choudhury, 2015) and Latin America (Castillo et al., 2014; Soto et al., 2015). However, the abandonment of jatropha cultivation (i.e. the disadoption process) has received less attention, as seems to be common when studying the adoption dynamics of new agricultural technologies (Walton et al., 2008). While there are some qualitative descriptions of the abandonment of jatropha cultivation (Ahmed et al., 2017; Slingerland and Schut, 2014), very few studies (Goswami and Choudhury, 2015) have analysed the reasons that lead farmers to disadopt jatropha cultivation using quantitative data. The integration of quantitative and qualitative data is needed to understand the interaction between rural households and technology adoption (Place et al., 2007), thus increasing the robustness of the findings. Assessing the motivations and factors that lead farmers to either continue to grow

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or disadopt jatropha, as well as the institutional context in which disadoption takes place, is an important step towards reaching a better understanding of the mechanisms and dynamics of bioenergy crops promotion programmes.

The central objective of this paper is to analyse the main socio-economic, institutional and environmental factors determining the decision to disadopt jatropha cultivation by farmers participating in smallholder-based projects. With this aim, we focussed our study on the State of Chiapas (Mexico). In 2007, the Chiapas Government began to promote jatropha and palm-oil based biodiesel production and use, with the creation of the Institute for Productive Reconversion and Biofuels (IRBIO). The promotion of jatropha cultivation by the Chiapas Government consisted of providing farmers with reproductive material (i.e. seeds and seedlings) and technical assistance for the establishment and maintenance of plantations. This promotion strategy was coupled with a national programme (so-called ProArbol) in which the Mexican Government offered economic subsidies to jatropha growers for the establishment and maintenance of jatropha plantations during the first plantation year (CONAFOR, 2009).

According to CONAFOR (2011), between 2007 and 2011, 8113 ha had been planted with jatropha in Mexico, of which 52% were in Chiapas. While visiting communities in Chiapas we noticed that jatropha abandonment was frequent among farmers that had adopted the crop. This abandonment was confirmed by Valero Padilla et al. (2011) who reported widespread abandonment of one year old plantations and by Takayuki et al. (2012) who reported an abandonment rate of 49%.

The underlying causes of jatropha disadoption in Chiapas have been analysed with qualitative techniques by Takayuki et al. (2012), who suggested that non-payment of subsidies and damage caused by rodents are the main factors determining disadoption. Here we use a combination of qualitative and quantitative approaches to disentangle the motivations and factors behind disadoption decisions. We first identified the socio-economic differences between farmers groups: farmers that did not try cultivating jatropha (non-adopters), farmers that tried jatropha but decided to abandon its cultivation (disadopters) and farmers that continue cultivating jatropha (ongoing adopters). Socio-economic factors (e.g. household characteristics, farm-level biophysical factors) have been reported to influence adoption decisions (Mercer and Pattanayak, 2003; Neill and Lee, 2001; Pattanayak et al., 2003). The knowledge of these factors may help policy makers in the design of future policy measures that support targeted households, and in discouraging bioenergy crops abandonment. Secondly, we analysed the main reasons that led farmers to abandon their jatropha plantations, looking at both intrinsic socio-economic factors, as well as extrinsic elements associated with the problems encountered during the process of jatropha promotion (e.g. failure in receiving subsidies). We also compared the relative importance of each factor on determining jatropha disadoption, thus identifying which features are more important and require more attention from policy makers and promoters of jatropha projects. This paper provides empirical data that will help policy makers, extension agents and advocates of jatropha, and other bioenergy crops, to identify the obstacles encountered during the adoption process and the motivations that may lead farmers to abandon jatropha cultivation. Additionally, it offers policy guidelines towards the enhancement of farmers' participation and retention by preventing failure of promotion strategies.

Methods

Conceptual framework

During any crop adoption process, farmers have to make two dichotomous decisions: adopt or not, and once the crop has been adopted, abandon or continue cultivating. The determinants of the first decision have already been studied in relation to jatropha in Chiapas (Soto et al., 2015). Therefore, in this study we will focus on the factors that discourage farmers and determine the abandonment of jatropha cultivation.

We assume that farmers decision to disadopt jatropha cultivation, as well as to adopt, is determined by their need to maximize utility or profit (Feder et al., 1985), i.e. a farmer continues to cultivate jatropha if the expected utility of persisting is greater than that from its abandonment. The expected utility of the household is a function of both household and farm-specific characteristics. According to Mercer and Pattanayak (2003) and Pattanayak et al. (2003), these features can be divided into five groups: household characteristics, resource endowments, market incentives, risk and uncertainly related to the technology and farm-level biophysical factors. Neill and Lee (2001) suggested that, in addition to previous intrinsic variables, the disadoption process is also influenced by other extrinsic factors associated with the experience and inconveniences encountered while adopting the technology. The variables included in this study, both intrinsic and extrinsic, are discussed in detail in "Description of variables" section.

We considered as disadopters those farmers that had adopted jatropha cultivation, but either removed or ceased managing their jatropha plantation when the survey was conducted (2011). The majority of the surveyed disadopters farmers (90%) kept their jatropha trees (either not undertaking any maintenance or pruning them). This may have been to avoid having to return the subsidies provided and/or to leave the option open to keep cultivating jatropha in the future. Those farmers who keep their plantations can use the land around the plants for either cropping or grazing until the jatropha canopy closes. Ongoing adopters were those who continued cultivating and maintaining the jatropha plantation (i.e. investing labour or inputs) that they had established three to four years before.

Data collection

We used a combination of quantitative data collected through a survey and qualitative information gathered in Chiapas at both the regional and community level through interviews and discussions. The State of Chiapas (Fig. 1) is one of the least developed regions of Mexico: it ranks first in rural poverty (CONEVAL, 2012), marginalization (CONAPO, 2012) and has one of the lowest Human Development Index of all Mexican states (UNDP, 2010). The population of Chiapas is very dependent on the primary sector (INEGI, 2010); animal husbandry and agriculture are the main activities representing 22% and 18% of Chiapas territory, respectively (SEMARNAT, 2009). Agriculture is based on traditional crops such as maize, beans, pumpkins and peanuts (INEGI, 2010).

Focus groups and key stakeholders discussions

Using the IRBIO census of the jatropha cultivators, which included information regarding jatropha plantations characteristics as well as the geographical position, we selected 6 communities that were growing jatropha to conduct focus groups discussions. We selected communities that in the view of extension agents of IRBIO represented diverse situations in terms of adoption rates and socio-economic conditions. During the period 2009–2011, focus groups discussions were conducted with community members that were cultivating jatropha on their farms. Additionally, we conducted 25 semi-structured interviews with key stakeholders including extension agents, government staff, social organizations, researchers and individual farmers. Key stakeholders were selected using a snowball sampling technique (Goodman, 1961). The information gathered in focus group discussions and interviews provided insight into the jatropha promotion, adoption and disadoption processes.

Questionnaires

We conducted a survey of 387 farmers in 16 randomly selected communities of Chiapas where jatropha promotion activities were taking place (Fig. 1). The survey was conducted between June and December