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Information networks that generate economic value: A study on clusters of adopters of new or improved technologies and practices among oil palm growers in Mexico

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ABSTRACT

The area under cultivation of oil palm has undergone considerable growth in Mexico, but yields are far below their potential. This is related to the low rate of adoption of new or improved technologies and practices in areas such as plantation management and farm administration. This study determines the factors that have an influence on adoption of new or improved technologies and practices and their relationship with the generation of economic value of oil palm. A cluster analysis of 33 key new or improved technologies and practices adopted by 104 growers was performed, and the main adoption categories and the variables influencing adoption are described. The results indicate that three clusters of growers can be discerned that differ in terms of their levels of adoption. The highest level of adoption of new or improved technologies and practices is related to higher yields and *vice versa*. The new or improved technologies and practices that differentiate the cluster of the advanced adopters from the cluster of the basic adopters are those related to plantation health, grower associations and production unit management. The cluster of the intermediate adopters is outstanding for their levels of adoption of new or improved technologies and practices in the aspects of plant nutrition, harvest, and genetics and reproduction. The advanced adopters set up better links for getting information, generally from their extensionists. The three clusters each exhibit a great degree of homophily, indicating little information flow between the different clusters of growers, while these can learn from each other. These results make it evident that better articulation among different clusters of growers and other actors should be encouraged, and that diversified and tailor-made extension strategies should be designed to optimally support different clusters of growers.

1. Introduction

Diverse studies have shown that low levels of productivity and competitiveness as well as inefficient agricultural production units can be partly explained by lack of knowledge on new technologies and deficient interaction among local actors leading to a low level of adoption of new or improved technologies and practices (Bozoğlu and Ceyhan, 2007; Feder and Umali, 1993; García et al., 2011; Hartwich et al., 2007; Martínez-González et al., 2011; Muñoz et al., 2007b; Muñoz-Rodríguez and Altamirano-Cárdenas, 2008). This is furthermore influenced by the broader institutional context in which farms are embedded which may be unfavorable in terms of input delivery systems and markets, for example (Hounkonnou et al., 2012). This also affects oil plam production in Mexico. The FAO (2011) reports that the area of oil palm harvested in Mexico has grown from 9000 ha in the year 2000 to 31,804 in 2010, a mean annual growth rate of 13.5% for the period. The growth of this harvested area can be explained by the fact that oil palm is more profitable than other farming activities such as livestock raising with pastures being converted to oil palm plantations. Another important reason is the policy of the Mexican government to promote these plantations, to enhance the wellbeing of the growers and to reduce the participation of oil imports in domestic consumption (SAGARPA, 2011). However, despite that oil palm production has undergone considerable growth, data from the FAO (2011) indicate that Mexico is only in 16th place worldwide as regards yield (13.78 t ha^{-1}), slightly

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above the world average (12.02 t ha^{-1}). However, it is still far below the highest yielding countries which display similar growth conditions but realize better yields: Nicaragua (24.33), Malaysia (21.90), Guatemala (21.82), Cameroon (20.72), and Colombia (18.79). So Mexico still lags behind in terms of productivity.

To improve the low yield in Mexico, it has been indicated that growers need to incorporate innovations in the form of improved technologies and growing practices in the production process (Muñoz et al., 2007b). Especially for small producers, agricultural extension services (also referred to as agricultural advisors, who can be either public or private, independent or linked to sales of goods – see Klerkx and Jansen, 2010) have been shown to be a major channel for the promotion of adoption of new or improved technologies and practices (Rogers, 2003), particularly strategies for conversion toward new types of production and optimizing growing practices. However, stimulating adoption of new or improved technologies and practices should not be seen as a linear process in which a state extension worker diffuses knowledge and technologies generated by research as this method has not been very effective in achieving adoption (Leeuwis and Van den Ban, 2004; Muñoz and Santoyo, 2010). One explanation for the ineffectiveness of this linear process lies in that it does not fully capture that changes at the farm result from different forms of social interaction (Dogliotti et al., 2014; Garb and Friedlander, 2014; Leeuwis and Van den Ban, 2004; Monge and Hartwich, 2008; Thuo et al., 2014). Rather, innovation and change at the farm level is the result of a complex, dynamic and interactive process that occurs within a heterogeneous set of actors (Klerkx et al., 2010; Muñoz and Santoyo, 2010; Radjou, 2004). Hence multiple sources of information play a role in informing adoption decisions (Isaac, 2012; Spielman et al., 2008), including sets of complementary extensionists with different types of expertise in pluralistic extension systems (Kilelu et al., 2014; Proctor et al., 2012; Rivera and Sulaiman, 2009; Klerkx and Proctor, 2013; Lubell et al., 2014).

In 2009 Mexico implemented a network model of extension for plantation crops in the wet tropics. The model operates through teams of extensionists with different sorts of expertise, called Agencies for Innovation Management (AIM, or AGI, in Spanish: Agencias de Gestión de la Innovación). To inform their extension activities, the AIM first makes a diagnostic of sources and flows of information for adoption of new or improved technologies and practices; they identify the key actors in the information network focusing on leading producers and other key influencing actors (e.g., agroindustry). With this information, the AIM develops a strategy that focalizes extension efforts on triggering processes of diffusion of new or improved technologies and practices among growers (Aguilar et al., 2011). This study analyzes the levels of adoption of new or improved technologies and practices of Mexican oil palm growers that participate in the AIM extension program. It analyzes the interactions among different actors whose aim is to innovate the agricultural production system of palm oil to generate more economic value for growers, and the role of the extensionists (who are private but paid with public resources) as network articulators. The objective is to determine the factors influencing oil palm growers to adopt new or improved technologies and practices and how they are related to generation of economic value, using multivariate methods. We determine to what extent higher levels of adoption of new or improved technologies and practices are connected to higher productivity and higher profits. The study groups the growers and analyzes the links they establish with their peers and other actors, using social network analysis.

The broader contribution the paper aims to make to the literature is twofold: 1) it aims to add to the literature on adoption of new or improved technologies and practices by showing how different networks of growers and extensionists lead to different economic impacts and 2) it aims to add to the literature in which calls have been made for more research on 'best-fit' extension approaches (Birner et al., 2009; Kilelu et al., 2014) and composition of information networks (Isaac, 2012) by showing how such differences in networks should connect to the organization of extension services. The paper is organized as follows. Section 2 provides a conceptual framework to set the basis for our research. The data description and the research methods used are presented in Section 3. This is followed by the analysis of the findings (Section 4). The paper ends with a discussion (Section 5) and conclusions regarding the policy implications (Section 6).

2. Conceptual framework

2.1. Adoption of technologies and practices in agriculture

While there is a lot of work in agricultural innovation studies that focuses on the generation of new or improved technologies and practices (see e.g. Klerkx et al., 2010), in this paper we focus on the process of broader diffusion and adoption of new or improved technologies and practices or what has been called 'scaling-out' (Garb and Friedlander, 2014; Hermans et al., 2013; Millar and Connell, 2009). Technologies include devices such as machines, and inputs such as fertilizers and pesticides, and practices may concern way of cultivation (planting weeding) but also the way in which farmers sell their produce (e.g., through traders, or direct sales on local markets) and buy inputs (e.g., from local stores, through contracts with agri-business). Often adoption is approached from a technology-push perspective and judged in terms of a scale ranging from 'innovators', 'early adopters', 'late adopters' to 'laggards', but this is generally done with a normative stance on what is 'good agriculture' and 'appropriate innovation', while different resource endowments and styles of farming go with different ways and rationales for adopting new or improved technologies and practices (Gilles et al., 2013; Leeuwis and Van den Ban, 2004). Also, some growers can adopt a technology or practice and then stop using it for a while, but then take it up again because it becomes useful given changed circumstances (Kiptot et al., 2007). Furthermore, while sometimes a technology or practice as generated by research or agribusiness is considered as a 'finished' innovation so a ready-made technology or practice which can be used as a 'turn-key' solution, it is only finished when it is integrated by farmers in their farming system and provides value (Leeuwis and Van den Ban, 2004). This may still require further adaptation to improve fit with the farming system or adjustment of the institutional context in which it will be embedded, or complemented with farmer-generated innovations (Douthwaite et al., 2001; Garb and Friedlander, 2014; Millar and Connell, 2009; Novo et al., 2014). An essential element in the adoption of technologies and practices that are not incremental and easy to fit within existing farming systems is that it requires working on a reconfiguration of institutional frameworks (such as rules, regulations, habits, values) (Hounkonnou et al., 2012; Klerkx et al., 2010; Muñoz et al., 2007b), and requires changes beyond the farming system level, for example in the context of the value chain.

2.2. Factors influencing adoption of technologies and practices

There have been several studies (see Pannell et al., 2006, for a review) on the factors influencing the adoption of new or improved technologies and practices in relation to grower characteristics, farming styles and resource endowments. In this paper, economic benefits of the adoption of new or approved technologies and practices are the main focus of the analysis, and several authors (Feder and Umali, 1993; Guardiola et al., 2002; Marra et al., 2003) state that producers expect to maximize their utility through the incorporation of new or improved technologies and practices