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Factors influencing technological practices in the Brazilian agrarian reform

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ABSTRACT

In recent decades, agriculture has responded to technology-related changes with strong productivity growth. Despite this evolution, the adoption of new technologies by small farmers has been a consistent challenge. In the coming years, the adoption of technology should be an essential element for the survival of small producers. To follow this evolution, the objective of this research is to identify factors that influence the adoption of higher levels of technological practices by producers of the agrarian reform in the Midwestern region of Brazil. Technological practices were evaluated based on the adoption of natural or chemical inputs, crop rotation, high yield seeds and mechanization. Higher levels of technological practices were defined as the joint use of these technologies, classified as technological packages. We identified two technological packages, one using natural inputs and the other chemical inputs. Questionnaires were applied to 1,162 settlers and the analytical model used was an ordered logit. Education, technical assistance and exchange experience with neighbors have a positive effect on technology use but do not favor the use of technological packages, which are instead favored by training courses in technology, partnerships with agro-food companies and resources available for investment. Thus, the government's priority should be to offer good technical support and access to training courses in technology. The financing of production costs did not show any effect on the adoption of technology, in contrast to funding for investments. Consequently, the financing of production costs should be reconsidered to favor greater technological investments.

1. Introduction

Agribusiness occupies a prominent position in Brazil's economy, having contributed 23.3% of the Gross Domestic Product in 2015 (CNA - Confederação, 2016). In addition to exports, this sector is a major contributor to Brazilian economic growth (Nogueira, 2013). It also helps to improve income distribution and social inclusion, particularly for family farmers, who in Brazil are defined as producers with areas of less than four fiscal modules, a unit of measurement that is expressed in hectares and varies in each Brazilian municipality due to its special features (art.50, Law 4,504/64).

Family farming represents 33% of the gross value of agricultural production and 74.4% of job creation in rural areas. A total of 12.3 million people are employed in this sector (MDA - Ministério do Desenvolvimento Agrário, 2014). Brazilian Law 11,326 of 2006 (Brasil, 2006v) defined a family farmer as someone who: (I) owns an area no larger than four fiscal modules; (II) predominantly uses the labor of his own family in the economic activities of his property; (III) has a minimum percentage of family income originating from the economic activities of his property (updated by Law No. 12,512, of 2011); and (IV) manages his property with his family.

To strengthen the role of family farming in rural development, the Brazilian government uses land reform, which, in addition to serving a social function, has the objective of promoting the redistribution of rural properties and thus promoting food production and income generation (Brasil Escola, 2013). Brazil has nearly 1 million families settled and distributed across an area of over 88 million hectares (INCRA, 2016).

In recent decades, agriculture has responded to technology-related changes with strong productivity growth. Agriculture is a fundamental instrument for sustainable development and poverty reduction, as experience with the Green Revolution has demonstrated (Wainaina et al., 2016; The World Bank, 2007). However, this requires making smallholder[1] farming more competitive and sustainable (The World Bank, 2007), which can be done through the introduction of improved agricultural technologies and management systems (Doss, 2006).

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[1] As Brazilian law considers family farmers as producers with a small production area, in the paper we consider family farmers, smallholders and small producers to be synonymous.

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Increasing the income of family farmers depends on increasing productivity and production, aspects linked to the adoption of more efficient technologies. These technologies are common in large properties but rarely found in small ones, leading to a separation between small and large establishments (Buainain and Garcia, 2013).

The adoption of technological innovations in agriculture has attracted considerable attention among development economists, but for Feder et al. (1985), the introduction of many Green Revolution technologies achieved only partial success, with low adoption rates. The "technology package" commonly used in modern agriculture, which is the joint adoption of the different technologies normally associated with the Green Revolution, such as fertilizer and proper soil management, is rarely used in family farming. The last Brazilian Agricultural Census in 2006 reveals that only 31% of small establishments use chemical fertilizer (Buainain and Garcia, 2013).

Considering the economic and technological changes in recent decades, which have increased productivity in the countryside, the need to adapt agricultural properties has become a matter of survival for farmers (Graziano and Navarro, 2015). Navarro (2015) offers an alarmist perspective regarding the future of small producers in Brazil, suggesting that two million farms — nearly half the current number — will disappear by 2030.

However, small farmers are heterogeneous and include traditional producers with native cultural heritage, indigenous people, farmers of European or Asian origin with a well-established market, and family farmers specializing in commodities (Buainain and Garcia, 2013). According to Navarro (2016), Southern Brazil, influenced by colonization by European descendants, has a family-based agriculture with great competitive capacity with regard to global markets, while the Midwest, North and Northeast have a pattern of traditional subsistence production and low market insertion.

Despite all the difficulties of family farming in North, Northeast and Central Brazil, the government believes that it plays an important role in providing food. Land reform aims to expand this role, particularly in regions in which land concentration is high, as in the Midwest. Brazilian agriculture occupies an area of 333 million ha, and the Midwest is the region with the largest production, with over 100 million hectares and 317,478 agricultural establishments. Meanwhile, this region has the smallest area occupied by family agriculture, with 9.4 million ha and 217,531 establishments (IBGE - Instituto Brasileiro de Geografia e Estatística, 2006). Thus, land reform is an alternative for achieving a more balanced distribution of land.

The difficulties of family farming and needs in terms of modernization raise some doubts about the chances for success of agrarian reform in the Western region of Brazil, where large-scale agriculture largely dominates. In the 2017-18 harvest, the region accounted for 45.4% of national soybean production, 50.6% of corn, 70.4% of cotton and 21.1% of sugarcane, crops which are typical of large-scale agriculture (CONAB - Companhia Nacional de Abastecimento, 2018a and b). The region has a high concentration of land ownership; in 2006, the date of the last agricultural census, the Gini index ranged from 0.86 for the states of Mato Grosso and Mato Grosso do Sul to 0.78 for the state of Goias (IBGE - Instituto Brasileiro de Geografia e Estatística, 2006), the three states of the Brazilian Midwest, and the Federal District, where the national capital is located.

Due to the difficulties faced by small farmers in the Midwest in adopting more efficient technologies and the strong presence of large-scale agriculture in the region — which further complicates the role of family farming — the following question can be raised: what are the factors that influence the use of modern technology among settlers of the Midwestern region of Brazil?

Many farmers use some type of technology, although this does not imply that they are efficient. Feder et al. (1985) mention the use of high yield seeds, which depends not only on the availability of the seeds but also some fertilizers. Ogada et al. (2014) add the availability of pesticide. For the authors, these technologies cannot be separated from one another.

Therefore, the main objective of this research was to identify factors influencing the adoption of higher levels of technological practices for these producers. By technological practice, we mean the use of technologies such as inputs, crop rotation, selected seeds and mechanization. Higher levels of technological practices were considered to be present when some technological package was used, which is the joint use of complementary technologies. We identified two packages commonly used in Brazilian agriculture. One consists of low external input strategies involving agronomic practices such as conservation tillage, other soil and water management techniques, and the use of organic manure. These agronomic practices are usually referred to as natural resource management (NRM) technologies or organic farming. On the other hand, intensification strategies (IIS) place greater emphasis on the use of improved seeds, mineral fertilizer, chemical herbicides and pesticides (Wainaina et al., 2016).

After presenting the literature on technology and family farming and the factors responsible for their adoption, we present the research methodology, followed by the main results and final considerations.

2. Technology and family farming

For Kageyama and Leone (2002), agricultural technology associated with modern tools such as machinery and tractors, chemical fertilizers and chemical control of pests and diseases results in high productivity. However, Houmy et al. (2013) present a broader view of agricultural technology. For them, in developing countries, technology covers all levels, from the most simple and basic instruments, such as hand tools, to the most sophisticated and powerful equipment.

According to Hoffmann (1992), modernization occurred heterogeneously; modern technologies have been used in Brazil's South, Southeast and some areas of the Midwest, while in the North, traditional agriculture predominates.

In addition to regional differences, there are differences between small- and large-scale farmers regarding their rate of technological adoption (Akudugu et al., 2012). IIS have been limited to large-scale farmers due to the high cost and technical constraints that required production scales too large for most small producers. This created a technological gap between small and large establishments (Buainain and Garcia, 2013).

Buainain and Garcia (2013) find that small producers with a low capacity for income generation possess technological deficits. Most possess insufficient land, low financial and human capital, a rudimentary level of productive organization and the location of their land has deep restrictions.

New farming technologies involve greater uncertainty than traditional ones. Therefore, risk-averse farmers would be less likely to adopt new technologies (Barham et al., 2014; Wainaina et al., 2016). Risk is an important element in agriculture, and poor people, being risk-averse, are reluctant to invest in modern technology (Juma et al., 2009).

The literature mentions subjective and objective risk. Subjective risk relates to the lack of sufficient knowledge to assess a new technology. Objective risk relates to the direct link between risk aversion and wealth. Poor farmers have limited economic margins with which to cope with uncertainty and limited possibilities for investment. Risk aversion is a key factor affecting smallholder adoption of technology (Fischer, 2016).

In addition to accumulated wealth, scale plays an important role in access to credit markets. According to Feder et al. (1985), various studies have found that lack of credit is an important factor limiting adoption of technology. Eba and Bashargo (2014) find that access to credit increases the probability of fertilizer adoption by 26.1%. Only when credit constraints are eliminated can technology benefit smallholders, a fact which is underscored by the importance of credit in the success of the Green Revolution in Asia (Fischer, 2016). Income and farm assets such as land and machinery are proxies for wealth. It is