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Measuring and understanding the drivers of agricultural innovation: Evidence from Ireland

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ABSTRACT

Despite the well-known importance of innovation to productivity growth in the agri-food sector, very few studies have attempted to measure farm-level innovation. This article contributes to the literature by developing an agricultural innovation index that goes beyond measuring innovation through adopted technologies. Based on this index, drivers and barriers of innovation are assessed. The findings reveal that innovation efforts differ between farm systems. Moreover, farm size and intensity, access to credit and agricultural education foster innovation, while increasing age and working off-farm hinder innovation. The paper concludes with policy recommendations to facilitate innovation in the agri-food sector.

Introduction

The agricultural sector faces significant challenges due to often competing economic and environmental targets. Within this context, agricultural innovation can contribute to achieving increased production while simultaneously preserving the environment. Therefore, facilitating agricultural innovation is vitally important for the future success of the food production sector. This has also been recognized by the EU with the creation of the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI), which aims to foster competitive and sustainable farming that "achieves more and better from less" (EIP-AGRI, 2014) and also aims to achieve greater diffusion of innovations into practice by an improved link between research and practical farming (EC, 2012). Moreover, it is widely recognized that continuing innovation is necessary in order to achieve sustainable intensification of the agricultural sector, where the adoption of innovative farming practices plays a key role (Leaver, 2010). In addition, the Common Agricultural Policy (CAP) continues to become more market orientated and simultaneously more focused on the environment. However, growing agricultural incomes, while maintaining the environmental sustainability of agriculture (within a policy environment in which income supports will remain decoupled from production) will require increased emphasis on improving the productivity performance of the agricultural sector. Continuing innovation is essential to enable this target to be achieved.

From the farm-level perspective, farmers need innovations that will increase efficiency and provide a competitive edge (Sumberg, 2005). While there is general agreement that innovation is important for the successful development of the food production sector (e.g., Spielman and Birner, 2008; OECD, 2013), less consensus exists on (i) measuring agricultural innovation and (ii) policy initiatives that foster innovation. One important step in facilitating innovation in the food production sector is to gain improved understanding of the innovation behavior of farmers. That is, developing methods to measure agricultural innovation as well as understanding its uptake are important means to improve our knowledge on this subject. Therefore, the objective of this article is to contribute to this knowledge gap by providing a measure of agricultural innovation and identifying factors that affect agricultural innovation.

This article focuses on agricultural innovation measurement and drivers and uses the Republic of Ireland as a case study. In recognition of the new challenges and opportunities facing EU and Irish farming in particular, the Irish government has set ambitious growth targets for the Irish agri-food sector. The policy document entitled 'Food Harvest 2020' (DAFM, 2010) emphasizes the key role of innovation in enabling farm households to strengthen their viability in an environment which aims to foster competitive and sustainable farming. Ambitious growth targets for the Irish agri-food sector are predicated on the idea of productivity growth through knowledge adoption by farmers and other economic agents within the sector. Therefore, given ambitious growth targets

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for the Irish agri-food sector, this case study is considered appropriate and timely. Despite focusing on Ireland, the developed agricultural innovation index and resulting policy recommendations are also relevant and applicable to other agri-food sectors.

This paper will proceed as follows: in the next section a review of relevant literature is undertaken and this is followed by a section outlining the methodology adopted for this study. The data is described in Section 'Data', while results are presented and discussed in Section 'Results and discussion'. Finally, the paper concludes with implications for policy and suggestions for future research.

Relevant literature

Until recently, the development and diffusion of agricultural innovations was seen as a linear process involving public sector research and extension organizations, which implicitly assumes that innovation is a product of research (Islam et al., 2013). However, agricultural innovation is increasingly seen as a process that involves the input of various actors and also as something that also depends on the social structure of the specific context (Knickel et al., 2009a). That is, agricultural innovation evolves as a result of interactions between different actors, such as farming systems, supply chains and economic systems, policy environments, extension and societal systems, which reflects the idea of Agricultural Innovation Systems (AIS) (Klerkx et al., 2012). This emerging approach provides a much broader perspective than the linear approach to innovation. Generally, an innovation system can be defined as: "a network of organizations, enterprises, and individuals focused on bringing new products, new processes and new forms of organizations into social and economic use, together with the institutions and policies that affect their behavior and performance" (World Bank, 2006, p. vi–vii). It becomes clear that the impact of a collaborative process that leads to innovation is increasingly recognized, which discards the linear approach to innovation as an almost simplistic way (Knickel et al., 2009a).

Regardless of how innovations are created, innovation is seen as the main driver of productivity growth in agriculture (OECD, 2013), therefore evaluating innovation is an important task that has attracted considerable interest in the literature. However, to date, efforts have mainly been confined to measuring agricultural innovation on a macro level. Spielman and Birner (2008), for example, identify a framework for the design and construction of national agricultural innovation indicators. As innovation is a complex process its measurement is generally conducted through a set of indicators that assess innovation efforts (i.e. national R&D or extension expenditure), outcomes (i.e. number of patents and publications) and impacts (i.e. total factor productivity growth) (OECD, 2013).

Considering the micro level, surprisingly few studies have focused on measuring agricultural innovation. However, a small number of studies do exist in the literature which have attempted to examine innovation at the farm level. An explanation for this scarcity in the literature may be the fact that agricultural innovation is a complex process that is hard to measure (OECD, 2013; VanGalen and Poppe, 2013). This process is further confounded by the fact that there is no clear definition of what classifies as an agricultural innovation. For example, an innovation can either be one change or a series of small incremental changes that leads to the introduction of a novel component on the farm (OECD, 2013). Understandably, available datasets rarely provide direct measures of farm level innovation.

One exception is the Farm Accountancy Data Network (FADN) dataset in the Netherlands. Based on this dataset, VanGalen and Poppe (2013) monitored innovation in the agri-food business sector and showed that three per cent of Dutch farmers were innovators in 2010. In this context, innovators were farmers who introduced innovative changes in products or production processes that were new to Dutch agriculture. An earlier example based on FADN data in the Netherlands was a study conducted by Diederen et al. (2003). The paper focused on innovation adoption of farmers and distinguished between innovators, early adopters and laggards. Here, innovation is assessed as whether or not a farmer had adopted and implemented an important innovation. Hence, this study considered a range of different innovations, such as the use of ultrasound to exterminate insects or a system for drying chicken manure. The different adopter categories were measured by the position of this innovation on the diffusion curve as indicated by the farmer.

Karafillis and Papanagiotou (2011) also provided an attempt to measure innovation based on primary data and designed a measure of farm level innovation to assess its impact on total factor productivity of Greek organic olive farmers. To this end, they constructed an innovation index that was based on farmers' uptake of different innovative technologies and farm practices. Another effort to measure farm level innovation was provided by Ariza et al. (2013) who developed a framework to measure innovation on farms in Columbia. Based on data gathered from a specific innovation survey, they designed an innovation matrix that was used to calculate an innovation index that gave a numerical value for innovation activity to each farm. The matrix was used to classify innovations as major, intermediate or minor based on their technological advancement.

While measuring agricultural innovation is still in its infancy, assessing factors that impact innovation adoption has received considerable attention in the literature. However, the vast majority of these studies used individual technologies as a proxy for agricultural innovations (e.g., Abadi Gadhim and Pannell, 1999; Dimara and Skuras, 2003; Lin, 1991; Sauer and Zilberman, 2012; Stefanides and Tauer, 1999), with Diederen et al. (2003) being one of the few examples that considered overall innovation adoption. Their study revealed that structural characteristics, such as farm size and age of the famer, explained differences in adoption behavior between different adopter groups, while information exposure distinguished innovators from the remaining groups.

The general paucity of studies focusing on measuring and assessing factors that impact on farm level innovation highlights the need for further research in this area. Therefore, this study contributes to the literature by developing a framework to measure agricultural innovation based on farm level data and assess factors that impact on innovation behavior.

In contrast to previous research (e.g. Ariza et al., 2013; Karafillis and Papanagiotou, 2011), this study accounts for the complexity of innovation by measuring innovation with a set of indicators that go beyond measuring innovation simply through technology adoption. Specifically, our study differs from previous research by combining expert opinions with farm level data to construct a sophisticated measure of agricultural innovation that is an expert weighted combination of three farm-level innovation specific indicators. Another important feature that distinguishes our study from previous research is that we assess factors that impact on innovation based on a composite index instead of a single technology, therefore resulting policy recommendations are relevant for fostering overall agricultural innovation.

Framework for assessing innovation

Agricultural innovation index

Innovation is seen as a broad concept that includes creation and/or adoption of innovations that can be new to the firm, new