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Enhancing adoption of agricultural technologies requiring high initial investment among smallholders

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ABSTRACT

Low and slow adoption of improved agricultural technologies among smallholders often frustrate technology development and promotion efforts in the developing world. That is especially true for technologies requiring high initial investment. This study investigates how increasing farmers' awareness and exposure to new agricultural technologies through the creation of systematic linkages in the research-to-development continuum affect adoption. The double hurdle and duration analysis models were applied to a sample of 820 smallholder households producing wheat and barley in Syria. The results show that increasing exposure and awareness of the zero tillage technology through organized field days and demonstration trials, complemented with providing free access to costly zero tillage seeders for first-time users, increases the propensity, speed, and intensity of adoption. The intensity of adoption is also positively influenced by wheat acreage and farmers' access to credit. The findings of this study highlight the importance of facilitating farmers' initial exposure and ease of trying out new agricultural technologies, especially those requiring high initial investment, at low or no cost in ensuring fast and large-scale adoption.

1. Introduction

In the developing world, new agricultural technologies are predominantly characterized by low and slow adoption adding to the frustration of researchers, development practitioners, policy makers and donors alike. Any new innovation carries both risks and opportunities and farmers are more likely to try out a new technology that is less risky and with higher expected benefits relative to the prevailing technology (Pannell et al., 2006). The decision on whether to adopt is even more challenging when the new technology involves high initial investment.

The decision to adopt a new technology, such as zero tillage (ZT), may be affected by several factors including farmer and farm household characteristics, farm biophysical characteristics, farm financial and management characteristics and exogenous factors beyond the control of the farmer. Among farmer characteristics, empirical evidence finds that the sex, age, education, and perceptions of farmers about inherent features of new technologies as important determinants of adoption (Baumgart-Getz et al., 2012; Vitale et al., 2011; Knowler and Bradshaw, 2007). Farm characteristics such as the size, location, soil properties, slope, proximity to homestead, access to irrigation water and the agro-ecological conditions of the area where the farm is located have also been found to affect adoption (D'Emden et al., 2008; Gedikoglu and McCann, 2012).

The adoption process involves a sequence of sub-decisions on when to try out the new technology, when to adopt, the intensity of adoption, and whether or not to fully replace the old with the new technology (Astebro, 2004; Jha et al., 1990; Smale et al., 1991). The ease with which the new innovation can be tested to confirm its advantages enhances farmers' tendency and speed to adopt and this may depend on the extent to which it may be tested at low or no cost (Pannell et al., 2006). The innovation's compatibility with existing set of resources,

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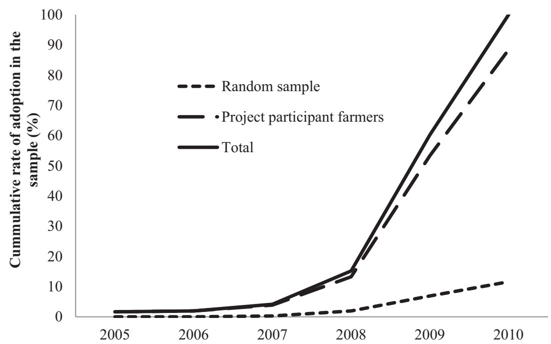

Fig. 1. Trend in the adoption of ZT among sample farmers.

practices and technologies may also influence the intensity of adoption. For instance, Zentner and Lindwall (1978) and Malhi et al. (1988) show that incompatibility with existing technologies and required high initial investments are contributing factors to low adoption of conservation agriculture (CA) in general, and zero tillage (ZT) in particular (Fig. 1).

In 2005, the International Center for Agricultural Research in the Dry Areas (ICARDA) launched a project to introduce and promote zero tillage (ZT), one of the 'pillars' of conservation agriculture (CA), to farmers in Iraq and Syria. The project adopted participatory methods to increase farmers' exposure to the new technology to encourage them to try it out and eventually adopt. Farmers were encouraged to carry out demonstration trials on their own farms by availing locally-made low cost ZT seeders to first-time users at no cost for up to two years while providing technical assistance and extension services. After the two years, farmers were left to decide whether they want to adopt the technology using their own or rented ZT seeders. Farmers were also encouraged to adopt other CA practices such as early sowing, use of low seed rates and residue retention. The detailed strategies used by the project to enhance ZT adoption is well documented (Loss et al., 2014; Piggin et al., 2015). By 2010/11 the total area under ZT had increased to about 15,000 ha and reached 50,000 ha by 2014/15. This rapid adoption is partly attributed to the shortage of fuel due to prevailing political instability in the country, necessitating the need to adopt the new technology.

El-Shater et al. (2015) investigated the economic benefits of the adoption of ZT among Syrian wheat farmers. The study found that after controlling for all confounding factors, adoption of the ZT technology led to a 25% (US$187/ha) increase in net crop income and a 34% (26.4 kg) gain in per capita wheat consumption per year (adult equivalent), which represent meaningful changes in the livelihoods of small and medium-scale wheat farmers. Numerous empirical studies have investigated the economic impact of adoption of new agricultural innovations. However, studies that document the efficacy of new innovation promotion strategies, especially those that require high initial investment, to enhance the speed, propensity, and intensity of adoption are sparse.

This study investigates the efficacy of promotion strategies in enhancing the decisions on the speed, propensity, and intensity of adoption of ZT among smallholder wheat and barley producers in Syria. The study makes two novel contributions to the existing literature. First, we show the importance of integrating research with development by allowing farmers to hold demonstration trials on their own farms as a pathway to promote uptake of new innovations and agricultural development. Second, we demonstrate the importance of providing risk-free environment to promote uptake on new technologies that require high initial investment.

The remainder of the paper is organized as follows. Section 2 provides an overview of the history of ZT in Syria followed by a description of the data used for this study in Section 3. Section 4 presents the methodologies used for the analysis. Estimation results are presented and discussed in Section 5. Section 6 concludes the paper with presentation of the major findings and their policy and extension implications.

2. Zero tillage and its promotion in Syria

Zero tillage (ZT) was little-known or tested in Syria before ICARDA introduced it via a project funded by Australian Agency for International Development (AusAid) through the Australian Center for International Agricultural Research (ACIAR) in 2005. The project discussed and demonstrated various ZT seeding technologies and requirements with local manufacturers in 2007 to 2008. Various prototype ZT seeders were developed with modifications to suit local conditions. To promote ZT in the region, the project purchased 10 ZT seeders from the local manufacturers and made them available for cost-free trial by interested farmers who wanted to try out the technology for the first-time on their own fields. While the project provided extension and advisory services to the first-time users, the farmers had to use their own tractors, fertilizers and other inputs. The project also organized and held field days on some of these demonstration sites to effectively promote the technology in a participatory approach.

The focus of the project in promoting the ZT technology was to demonstrate to farmers the immediate cost savings and potential yield increases as compared to conventional tillage practices (Loss et al., 2014). The gains in yields were expected to come from two sources. First, moisture being a major limiting factor in Syria, ZT helps the conservation of moisture which leads to yield gains. Second, given the amount of tillage needed and pressure on labor and machinery, farmers in Syria normally wait until after mid-October to plant wheat. The introduction of ZT would reduce the pressure on labor and machinery and adopters of ZT would be able to plant earlier without waiting for the first rains. Consequently, by 2010 the total area under ZT had reached about 15,000 ha with 70% of this estimated to be actual adoption by farmers using their own, rented, or borrowed ZT seeders. The remaining 30% was sown with local ZT seeders freely provided to first-time users without charge by the project implementers (ICARDA, Aga Khan Foundation and Aleppo Agricultural Machinery Center).

3. Data

The data used for this analysis comes from a farm survey conducted in 2011 by ICARDA scientists and the national extension program of Syria. The survey covered 28 randomly selected villages distributed across 17 districts and 7 main wheat-growing governorates. Cluster sampling procedure was used to collect the data with the different administrative units used as clusters. Using power analysis (Cohen, 1988), the minimum sample size required under the simple random sampling technique for ensuring 95% confidence and 3% precision levels in capturing up to 10% adoption was determined to be 374. Accounting for the design effect, the minimum sample size under the cluster sampling technique required for ensuring the same levels of confidence, precision and adoption levels was estimated to be 459, with an optimal cluster size of 17. The primary sampling units (PSUs) were the villages. Accordingly, a decision was made to take a random sample of 500 farmers uniformly distributed across all the 28 sample villages (about 18 farmers in each village).

Given the short history of ZT in the study area, the number of adopters in the random sample was found to be only 42, which was not considered adequate for statistical analysis. Therefore, in addition to the random sample of 500 farmers, 320 additional farmers, who had previously tested ZT on their own farms through the project's participatory development and extension program, were added, making the total sample size to be 820 farm households. Details of the sampling design are summarized in Table 1. All the 320 farmers had tried the ZT technology at least once, in tests or 'demonstrations' involving ZT and conventional tillage comparisons and were still using the technology