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Farmer-led innovations and rural household welfare: Evidence from Ghana

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ABSTRACT

It is well recognized that agricultural innovations could emerge from many sources, including rural farmers. Yet the numerous micro-level studies on impacts of agricultural innovations have largely focussed on externally promoted technologies, and a rigorous assessment of impacts of farmer-led innovations is lacking. We address this issue by analyzing the effect of farmer-led innovations on rural household welfare, measured by income, consumption expenditure, and food security. Using household survey data from northern Ghana and applying endogenous switching regression and maximum simulated likelihood techniques, we find that farmer-led innovations significantly increase household income and consumption expenditure per adult equivalent. The innovations also contribute significantly to the reduction of household food insecurity by increasing food consumption expenditure, by decreasing the duration of food shortages, and by reducing the severity of hunger. Furthermore, we find that these effects are more pronounced for farm households whose innovative activities are minor modifications of existing techniques. Overall, our results show positive welfare effects of farmer-led innovations, and thus support increasing arguments on the need to promote farmer-led innovations (which have been largely undervalued) as a complement to externally promoted technologies in food security and rural poverty reduction efforts.

1. Introduction

Despite increased food production in the last decade, nearly 850 million people (12% of global population) continue to be hungry and food insecure, and many more are micronutrient deficient (Godfray et al., 2010; FAO et al., 2013). Most of these undernourished people are smallholders, who live in rural areas and on less than US$1.25 a day and derive their livelihoods from agriculture (McIntyre et al., 2009). Agricultural innovations can play essential roles in tackling the global food security challenge (Brooks and Loevinsohn, 2011) and in reducing rural poverty (de Janvry and Sadoulet, 2002). Over the past years, there has been increased development and diffusion of technological innovations by scientists, and farmers are being encouraged to adopt these innovations (Gatzweiler and Von Braun, 2016). With the rapidly changing economic environment, however, farmers have gone beyond the adoption of the externally promoted innovations to develop their own technologies and to modify the externally introduced technologies to suit their local environments (Reij and Waters-Bayer, 2001; Sanginga et al., 2009; Tambo and Wünscher, 2015). Such innovation-generating practices among farmers, which are commonly referred to as farmer-led innovations, are claimed to play an important role in building local resilience to changing environments and in addressing food insecurity challenges (Reij and Waters-Bayer, 2001; Kummer et al., 2012; Tambo and Wünscher, 2017).

Following Waters-Bayer et al. (2009), we define a farmer-led innovation to be a new or modified practice, technique or product that was developed by an individual farmer or a group of farmers without direct support from external agents or formal research.[1] Thus, farmer innovators are farm households who have developed new techniques, tools or practices; have added value to common or traditional practices; or have modified external

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[1] Other terms for farmer-led innovations include farmer innovations and farmer-driven innovations.

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techniques or practices to suit their local conditions or farming systems.[2] Therefore, simply adopting externally promoted technologies is not part of farmer-led innovations.

There has in recent years been a surge of interest in analyzing the role of agricultural innovations in reducing poverty, hunger and malnutrition in developing countries. Many micro-level studies (e.g., Kijima et al., 2008; Minten and Barrett, 2008; Kassie et al., 2011; Asfaw et al., 2012) have shown that agricultural innovations have positive productivity, income, food security, and poverty reduction effects among adopters. These studies are, however, based on innovations developed and disseminated by National Agricultural Research System (NARS) and the Consultative Group on International Agricultural Research (CGIAR), and there is little evidence on the contribution of farmer-led innovations to economic well-being of farm households. Considering the numerous challenges hindering poor rural smallholders' adoption of externally promoted innovations (Barrett et al., 2004), it has been argued that farmer-led innovations might form the basis for rural livelihoods and food security (Reij and Waters-Bayer, 2001; The Worldwatch Institute, 2011). However, the few studies that have examined the potential impacts of farmer-led innovations (e.g., Reij and Waters-Bayer, 2001; Leitgeb et al., 2013; Kummer et al., 2017) were based on farmers' subjective perceptions of the outcomes of their innovations or on selected case studies of farmer innovators, and did not account for possible selection bias. Thus, a rigorous assessment of the impact of farmer-led innovations is still lacking. Robust evidence is needed to be able to support increased arguments on the need for policy supports on farmer-led innovations as a complement to externally introduced innovations.

Using survey data from farm households in northern Ghana, this study attempts to fill the void on the impacts of farmer-led innovations. Specifically, we examine whether farmer innovators are better off than non-innovators in terms of household income, consumption expenditure, and food and nutrition security. On the one hand, farmer-led innovations may improve productivity or save labour for non-farm activities and subsequently increase household income and food security. On the other hand, it is possible that the innovations developed by farmers may be unsuccessful or may not produce immediate result, hence, has negative effect on household income and food security. We employ endogenous switching regression and a maximum simulated likelihood estimator to account for potential non-random selection bias. We complement the regression results with analysis of perceived outcomes of farmer-led innovations as reported by the innovators.

The rest of the paper is organised as follows. The next section presents the conceptual framework and estimation techniques. In section 3, we describe the welfare outcome indicators, followed by a presentation of the data and descriptive statistics in section 4. The empirical results are presented and discussed in section 5, while the last section summarises and concludes the paper.

[2] The questions used to elicit farmer-led innovations can be summarized as follows. Have your household in the past year develop any new agricultural technique or did you modify or make any changes to farming techniques or practices in your community, on your own or jointly with other farmers without direct external assistance (e.g., from extension agents, researchers, NGOs, etc.)? If yes, please describe the practice. *Note:* All the practices described by the farmers were verified by confirming if they can be considered as farmer-led innovations. With the assistance of extension agents and experts who are knowledgeable about agricultural practices in the sample communities, we confirmed if a practice described by a farmer was not a common practice but rather a modified, an improved or a novel practice.

2. Conceptual framework and empirical approach

In order to assess the effect of farmer-led innovations on household well-being, the farm household model that posits that households maximise utility subject to income, production, and time constraints (Singh et al., 1986) is used as a framework. The model integrates in a single framework, the production, consumption and work decision-making processes of farm households (Sadoulet and de Janvry, 1995).

Following Weersink et al. (1998) and Fernandez-Cornejo et al. (2005), households are assumed to derive utility (U) from purchased consumption goods (G) and leisure (L), and the level of utility obtained from G and L is affected by exogenous factors such as human capital (H) and other household characteristics (Z). Thus:

$$MaxU = U(G, L; H, Z) \tag{1}$$

Utility is maximised subject to:

$$\text{Time constraint}: \quad T = F\left(I_f\right) + M + L, M \geq 0 \tag{2}$$

$$\text{Production constraint}: \quad Q = Q\left[X\left(I_f\right), F\left(I_f\right), H, I_f, R\right], I_f \geq 0 \tag{3}$$

$$\text{Income constraint}: \quad P_g G = P_q Q - W_x X' + WM' + A \tag{4}$$

The total time endowment (T) of each household is allocated to leisure (L), working on the farm (F), or off-farm work (M). The level of farm output (Q) depends on the quantity of farm inputs (X), the innovativeness of farm household (I_f), F, H, and a vector of exogenous variables that shift the production function (R). X and F are functions of I_f since some of the farmer-led innovations are labour or input saving, hence, freeing some time and money for other uses. I_f in turn is determined by households' experience of shocks, social capital, household assets, risk preference, H and Z.

Equation (4) depicts the budget constraint on household income where P_g denote price of goods purchased. Thus, $P_g G$ is the income available for purchase of consumption goods, and it depends on the price (P_q) and quantity (Q) of farm output, price (W_x) and quantity (X) of farm inputs, off-farm wages (W) and the amount of time spent working off-farm (M) and exogenous household income such as government transfers, pensions and remittances (A).

Substituting Equation (3) into Equation (4) yields a farm technology-constrained measure of household income:

$$P_g G = P_q Q\left[X\left(I_f\right), F\left(I_f\right)', H, I_f, R\right] - W_x X' + WM' + A \tag{5}$$

The Kuhn-Tucker first order conditions can be obtained maximising Lagrangean expression ($\mathscr{L}$) over (G, L) and minimising it over (λ, η):

$$\begin{aligned}\mathscr{L} &= U(G, L; H, Z) \\ &+\lambda\left\{P_q Q\left[X\left(I_f\right), F\left(I_f\right)', H, I_f, R\right] - W_x X' + WM' + A - P_g G\right\} \\ &+\eta\left[T - F\left(I_f\right) - M - L\right]\end{aligned} \tag{6}$$

where λ and η represent the Lagrange multipliers for the marginal utility of income and time, respectively.

Solving the Kuhn-Tucker conditions, reduced-form expression of the optimal level of household income (Y^*) can be obtained by (Fernandez-Cornejo et al., 2005):