Food Policy 75 (2018) 37–51

Contents lists available at ScienceDirect

Food Policy

journal homepage: www.elsevier.com/locate/foodpol

The gender and geography of rural off-farm employment and input intensification in five sub-Saharan African countries

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1. Introduction

The need for accelerating yield growth cannot be overemphasized in sub-Saharan Africa (SSA) because farm productivity levels are still very low. For example, over the past decade for which data is available (2005–2014), cereal yields in SSA averaged only 1.3 tons ha^{-1} compared with the global average of 3.6 tons ha^{-1} (World Bank, 2016). Yet, a key limiting factor is low input adoption and intensity in the presence of poor soils and rainfed dominated production systems. For example, average fertilizer consumption in SSA over the period 2005–2014 averaged only 14 kg ha^{-1} of arable land compared with the world average of 127 kg ha^{-1} (World Bank, 2016). However, recent evidence (Sheahan and Barrett, 2017) points to an increasing use of fertilizers although the use of other modern technologies, irrigation in particular, remain low.[1]

Sheahan and Barrett (2017) also found that farmers in SSA rarely use credit to purchase farm inputs. Indeed, in our data only 15% of farmers reported using agricultural input credit across all five study countries (ranging from 6% in Malawi to 30% in Kenya). Worse still, participation in input credit use dropped significantly from 19% in 2002 to 14% in 2013. At the same time, however, fertilizer adoption rates, for example, increased from 57% of all farmers in our sample in 2002 to 74% in 2013. These facts naturally raises the question of how farmers are financing inputs. Input subsidies could be one channel but political patronage and corruption bedevils smooth implementation (Jayne et al., 2013; Takeshima and Liverpool-Tasie, 2015).

A recent study by Adjognon et al. (2017) found off-farm activities and crop incomes to be important sources of liquidity for financing purchased inputs. Indeed, the link between rural off-farm employment (ROFE) and purchased input use has previously been explored (e.g., Oseni and Winters, 2009; Mathenge et al., 2015). The finding that off-farm income is positively correlated with purchased input use is not surprising given the well-known and documented evidence of thin or nonexistent agricultural capital markets (particularly for credit) in many rural areas of SSA (Udry, 1994; Conning and Udry, 2007; Karlan et al., 2014).

This article seeks to advance knowledge on household-level linkages between ROFE and agricultural intensification (i.e., fertilizer adoption) by answering the important question of whether or not the link is different for women and men. Surprisingly, although the literature abounds with studies that explore gender gaps in agricultural production and input use (e.g., Ndiritu et al., 2014; Slavchevska, 2015), as well as show that ROFE is gendered (e.g., Canagarajah et al., 2001; Rijkers and Costa, 2012), the gendered link between ROFE and farm outcomes has not been previously explored in any systematic manner, to the best of knowledge.

Aside seeking to fill this important gap in the literature, another novelty of the present article is the utilization of a unique panel dataset with identical survey instruments covering 45 villages in five SSA countries (Ghana, Kenya, Malawi, Tanzania and Zambia) over a 14-year period (2002–2015). The sampling strategy adopted for collecting the data (Section 3) also allows us to test whether or not the relationships of interest differ across relatively well– and less-endowed regions (defined below). This distinction is important because intensification incentives, capital market constraints, infrastructure, and off-farm labor market activity could be spatially heterogeneous. This implies that the potential role of ROFE in easing the credit market constraint, for example, could differ spatially. Such spatial-specific analysis could help our understanding of the geographic nuances underlying the correlation between ROFE and intensification.

The rest of the article is structured as follows. Section 2 provides an overview of the related literature. Section 3 contains the conceptual and empirical models; Section 4 describes the data, followed by a descriptive analysis in Section 5. The regression results follow in Section 6, and Section 7 concludes.

2. Gender, rural off-farm labor market activity and farm investments

2.1. Gender and rural off-farm income

Although ROFE activities and impacts are generally context-specific, they are gendered in some cases. For example, women were less likely to be nonfarm entrepreneurs in Bangladesh, Indonesia and Sri Lanka but not in Ethiopia (Rijkers and Costa, 2012). In rural Rwanda, female-headed households were less likely to participate in both nonfarm

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[1] Unless otherwise specified, fertilizer refers to inorganic or chemical fertilizers.

https://doi.org/10.1016/j.foodpol.2018.02.003
Received 2 December 2016; Received in revised form 3 February 2018; Accepted 9 February 2018

wage– and self-employment (Ali et al., 2014). In Ghana, on the other hand, self-employment tends to be more common among women than men, whereas the opposite is generally true for wage-employment (Newman and Canagarajah, 2000; Ackah, 2013). A reason for this could be that self-employment activities are more compatible with reproductive activities than wage-employment.

Asset endowment matters for entry into high-return niches of ROFE (Barrett et al., 2001), and since the literature (Deere and Doss, 2006; Deere et al., 2013) suggests that asset accumulation is generally gendered, one would expect high-return ROFE opportunities to also be gendered. Some evidence (Lanjouw and Feder, 2001; Hazell et al., 2007) supports this view. But there is also contrary evidence: Andersson Djurfeldt et al. (2013) used data for 21 regions in eight African countries to show that women were not more likely to engage in low-return type ROFE than men. Their study also reinforces the context specificity of the gender differences in off-farm participation—whereas there were no gender gaps in off-farm participation in *poor* regions, women's participation was higher than men's in *rich* regions.[2] It has also been suggested that where women's access to land is limited, they are forced to seek income earning options off-farm, making them more dependent on ROFE than men (Yunusa, 1999).

Even if ROFE opportunities tend to be more egalitarian than large-scale industrialization in general as suggested by Bagachwa and Stewart (1992), the impacts may not necessarily be the same for women and men. Studies have shown that off-farm earnings could either dampen or exacerbate inequality (e.g., Haggblade et al., 2010; Himanshu et al., 2013), but this could differ by gender. For example, in Ghana, Canagarajah et al. (2001) found that nonfarm income was associated with inequality among female-headed households than it was among male-headed households. This suggests that the barriers of entry into more remunerative ROFE (e.g., education and financial capital) works more against women than it does against men.

These findings show the need for taking gender into account when analyzing the relationship between ROFE and farm outcomes. Related to this is the possibility that rural off-farm self-employment (ROFSE) and wage-employment (ROFWE) could have different effects on farm outcomes because they are also gendered.

2.2. Gender and farm input use

Although the evidence is inconclusive, the received wisdom is that agricultural input adoption rates are generally lower among women than they are among men (e.g., Smale et al., 1991; Kumar, 1994; Udry et al., 1995; FAO, 2011; Theriault et al., 2016). A review of the relevant literature is provided by Ragasa (2012). It is important to note, however, that the gender comparison could be more complex and depends on whether one is comparing male-headed versus female-headed households or female farmers versus male farmers in general. In their study on gender and improved maize variety adoption in Ghana, Doss and Morris (2001) found no significant difference between female and male farmers. Similarly, Smale (2011) and Ndiritu et al. (2014) found no significant association between sex of household head and the adoption of improved seed varieties and fertilizers in Kenya. Indeed, some evidence from Kenya and Tanzania suggests that the intensity of fertilizer use is higher among female-headed households than it is among male-headed households (Winter-Nelson and Temu, 2005; Alene et al., 2008).

In Malawi, a country that has been extensively cited for its farm input subsidy program in recent years, Fisher and Kandiwa (2014) show that female-headed households and women in male-headed households had lower modern maize adoption rates compared with male-headed households. However, fertilizer subsidies tended to reduce the gender gap. The key message is this: gender differences in agricultural input use must be found in specific contexts.

2.3. Rural off-farm employment and farm investments

The conceptual link between household engagement in ROFE and agricultural intensification (e.g. increased use of productivity enhancing inputs) is ambiguous *ex ante*, that is, it depends on household labor constraint and allocation decisions, occupational choice (or the lack thereof), and meso/macro-economic factors that condition these choices and constraints (Ellis, 2000). The availability, structure and conduct of capital markets (particularly credit, if available) are all important conditioning factors in the relationship between ROFE and farm investments (Reardon, 1997).

As one could expect, the empirical evidence is mixed and context-specific. A number of studies (e.g., Reardon et al., 1992; Savadogo et al., 1994; Oseni and Winters, 2009; Anriquez and Daidone, 2010) provide empirical evidence in support of the view that in the absence of well-functioning credit markets, off-farm income serves as a substitute, and therefore positively associated with intensification. Per contra, if the marginal physical product of labor is non-declining and hired labor markets are prohibitive, then the movement of resources from the farm to ROFE activities could have negative effects on farm outcomes. It is not surprising then that some have found ROFE to be negatively correlated with farm input use (Ahituv and Kimhi, 2002; Kilic et al., 2009; Pfeiffer et al., 2009; Mathenge et al., 2015). Do these results differ by gender and geography? This article seeks to answer this important question.

3. Conceptual and empirical models

A farm household's fertilizer adoption decision is a derived demand founded on the demand for crop output. Beginning with the production function and assuming, for example, that the farm household's objective is to minimize cost of production subject to a given level of output, solving the cost minimization problem yields input (including fertilizer) demand functions whose arguments are input and output prices. Other factors include the availability and price of substitute and complementary inputs. Production function shifters such as improved technology (including the availability of irrigation), crop type, and the production environment (proxied by agro-ecological dummies) all influence the demand for fertilizer. The conceptual model can be written as

$$fertilizer = fertilizer(p, p^s, p^c, p^o, ROFE, I, H; \xi), \quad (1)$$

where p is the price of fertilizer, p^s is price of a composite substitute input, p^c is price of a composite complementary input, and p^o is output price. The ability to purchase fertilizer is determined by farm household liquidity, for which ROFE and nonlabor income (I) could be important. Household assets (including livestock) could also enter Eq. (1), and can be used to assess the presence of a binding credit constraint, which could limit poor farmers' fertilizer adoption (Lamb, 2003). Household demographics, H, are important factors that could influence farmer behavior. Finally, ξ represents contextual factors such as the policy and institutional environment, which influences factors such as the availability of input credit, and extension services, for example.

The main objective of this article is to examine the nexus between gender, geography, ROFE and fertilizer adoption among rural African smallholders. As is common among this group of farmers, however, the outcome variable of interest (i.e. quantity of fertilizer use per hectare) has a corner solution at zero. This requires the application of the Tobit estimator, which in the panel data context can be specified as

[2] Rich versus poor regions were defined largely in relation to agro-productivity potential and economic dynamism.