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**Demand-led and supply-led extension approaches to support sustainable intensification in Malawi**

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**Background:**

Agricultural extension systems are intended to help farmers raise their productivity and adapt to changing environmental conditions. However, there has been widespread dissatisfaction with the performance of agricultural extension institutions in Africa. Frustration with past approaches to extension (e.g. training and visit, public extension systems) has led to has led to repeated calls for innovative new approaches to transition from ‘supply-driven’ technology transfer models to ‘demand-driven’ approaches where farmers and researchers interact with extension systems in a participatory process (Briggs, 1990; Snapp et al., 2003).

Given the universally acknowledged importance of extension, it is surprising how little research there is on the effectiveness of alternative extension models in Africa. There are, to be sure, comprehensive and useful evaluations of alternative approaches (e.g., Dejene, 1989; Biggs, 1990; Grabowski, 2014; Davis *et al.,* 2012; Wellard et al., 2013). Davis *et al* examined Farmer Field School approaches, which is a form of participatory action education and demand-driven extension; this was shown to be notably successful in improving incomes and farmer knowledge at three sites in East Africa. Further, a study of participatory research and extension in Southeast Asia found that the capacity-building components supported farmer adoption of soil conserving technologies in addition to benefits accruing from the promotion of new technologies (Dalton et al., 2011). However, none of these studies evaluated conventional supply-driven extension approaches against more participatory, demand-driven approaches. Moreover, there is virtually evidence based on detailed farm panel data to systematically evaluate the effectiveness of demand-led extension programs in promoting sustainable intensification practices. Panel analysis techniques provide the potential to control for unobserved farm and plot conditions that plague other kinds of studies evaluating the effects of alternative extension programs.

**The Study**

We evaluate conventional supply-driven extension approaches against more participatory, demand-driven approaches on how they affect households decision to adopt five sustainable intensification technologies in two central districts of Ntcheu and Dedza in Malawi. The analysis is based on a panel of roughly 640 maize plots on 320 smallholder farms in two districts of Malawi over four years from 2013 to 2016. The analysis compares four alternative types of farmer contact with extension services: (i) no extension contact (36.5% of all sampled households), which is the control group; (ii) received extension services from Africa RISING, where farmers were encouraged to conduct their own experimentation with the practices promoted by Africa RISING (7.8%); (iii) interaction with Malawian Government Extension staff (13.3%); and (iv) interaction with both Africa RISING and government extension staff visits (42.2%). Africa RISING (AR) features a demand-led approach where farmers are encouraged to experiment with technologies such as maize-legume intercropping, cultivation of pigeon pea, 3-season crop rotations featuring maize/pigeon pea, groundnut/pigeon pea, and maize monocrop, and the use of organic and inorganic fertilizers. AR’s promotion of pigeon pea is based on the voluminous biomass generated by this plant, which can therefore raise levels of soil organic matter more quickly than most other crops. Pigeon pea also provides expanding market demand and the nutritional benefits of a more diversified legume-dense diet. We use econometric techniques to estimate the probability of farmers adopting these technologies and practices on their most and least fertile maize fields conditional on participation in these four extension categories (none, AR, government, both AR, and government).

The study is also designed to understand how risk aversion and high time-preferences for money affect farmer willingness to adopt sustainable intensification practices. Many such practices require significant labor input or cash costs up front even though the yield benefits may not manifest until several years into the future. Future benefits may be substantial; however, households with severe food insecurity challenges may prioritize farming practices that provide the most immediate benefits, regardless of long-term consequences. Relatedly, poor farmers are loathe to take risks, and this is another potential impediment to the adoption of untested sustainable intensification practices. The trust that farmers put in alternative extension approaches, and the ability for them to experiment without risk are therefore important issues. Evidence on what extension approaches are most effective for smallholder farmers can provide valuable guidance to governments and development partners in Malawi and the wider region.

**MAIN FINDINGS**

## *Technology 1: Crop rotation*

Farmer adoption of crop rotations were strongly and positively influenced by combined extension contacts from AR and the Government extension service. The probability of practicing maize-legume rotation was highest on plots owned by male household heads and on plots regarded as less fertile by the household. This may follow from the fact that rotations are an important means of rebuilding soil fertility and organic matter. Counter to the view that crop rotations is more likely to be adopted by hosueholds with greater farm sizes, our results show no significant relationship between households with more land endowments and the probability of practicing crop rotation.

## *Technology 2: Maize-legume intercrop*

Households practicing maize-legume intercrops were more likely to have older household heads, larger plots, and more fertile plots. Interestingly households that are perceived to be less risk-averse than most other households had the high probability of intercropping maize and legumes. And households intercropping legumes and maize were less likely to be in contact with Africa RISING. It should be noted that legumes such as groundnut and beans have been grown for decades in the sampled districts of Ntcheu and Dedza, and in recent years’ soybean has become a relatively common crop. Knowledge about maize-legume intercropping is already quite widespread, hence even for households that had no extension advice, there is a high probability that farmers will be practicing intercropping. Moreover, because farmers in contact with AR are more likely practice rotations over time, it is therefore understandable that continuous practice of maize-legume intercropping might be somewhat lower among farmers liaising with AR.

## *Technology 3: Pigeon pea*.

Pigeon pea is not a traditional crop in the study area; indeed, it is rarely grown in Central Malawi. This provided an excellent opportunity to evaluate the effectiveness of the extension methods that were used. The study found that both AR and Government extension services promoted farmers’ use of pigeon pea over time compared to farmers with no extension contact. Farmers who were in contact with both AR and government extension agents were especially likely to adopt pigeon pea. Fields that were grown to maize in 2014 were also most likely to be planted to pigeon pea in later years among farmers with AR contact, indicating that pigeon pea has moved from experimental plots tried out on a few AR farmer farms, on to regular maize panel fields in just a couple of years.

Under AR, farmers learned about pigeon pea through learning by doing on farmers’ own plots and by growing pigeon pea on group demonstration plots. Seed was provided for improved pigeon pea varieties so that farmers could try out this technology in ‘baby trials’ on their own plots. The number of households adopting pigeon pea has steadily increased from 2014 to 2016. The probability of intercropping maize and pigeon peas increases with larger plots, particularly for households with relatively smaller total land holdings and among households that not highly averse to risks (and therefore more willing to experiment with new practices). Both AR and Government extension staff contact promote the probability of farmer adoption of pigeon pea, and the greatest probability of adoption was on plots managed by farmers in contact with both AR and government extension agents. Notably, farmers who were less averse to risks than other farmers were more likely to experiment with and reap the benefits of growing pigeon peas in mixed maize systems. These results indicate the significance and positive effect of the extension method that allowed farmers to choose which technologies to try out (demand-driven) and to practice the technology on their plots (participatory action research through mother and baby trial design, Snapp et al., 2002).

## *Technology 4: Inorganic fertilizer*

The probability of incorporating inorganic fertilizer was highest on smaller plots, among male-headed households and households with larger landholdings. Interestingly, inorganic fertilizers were more likely to be applied on plots specified by farmers as fertile compared to infertile. The results indicated that 141kg/ha more fertilizer was applied on fertile maize plots than less fertile maize plots. Given the cost of purchasing fertilizer, it may not be financially possible for households to apply fertilizer on all crops, hence the observed pattern of concentrating fertilizer use on smaller plots with high productivity. No significant relationship is observed between extension contact and farmers’ application of inorganic fertilizers. These findings indicate that constraints on the use of fertilizer by Malawian farmers are not primarily related to knowledge about the benefits of fertilizer, which seems highly reasonable in Malawi and other regions where the use of fertilizer has been widespread for decades (Denning et al., 2009). Access to finance and ability to take risks appears to be the main constraining factors.

## *Technology 5: Organic manure*

Male household heads were more likely to apply manure on their plots than on women’s plots. Organic manure contributes to weed growth as well as plant growth, and male heads are perceived to be better able to mobilize weeding labor than women. This gendered-challenge of labor access has frequently been noted in the literature and needs to be given full consideration in the development of extension recommendations (Doss, 2001). More fertile plots receive 126kg/ha more organic manure that less fertile plots. This could however also be related to field location about livestock (which was not tested here) – as higher fertility fields may have benefited historically from being near livestock holding pens that reduce the labor required for transportation and thus facilitate the use of manure (Rusinamhodzi et al., 2016).

In terms of extension services effectiveness, households that applied organic manure had very significant interactions with extension messages from Africa RISING alone, or the combination of Africa RISING and Government extension. Farmers engaged with both extension approaches used about 70% more manure per hectare in the most recent survey year (2016) compared to others farmers. Manure and compost are knowledge-intensive technologies requiring skill on how best to produce and apply it as well as guidance on the appreciation of manure as a nutrient source that supports the accumulation of soil organic matter over time (Ogunwole, 2008). Thus, it was not surprising that manure use was enhanced through a more intensive extension approaches that included both demand-led and supply-led systems.

**Concluding Remarks**

This study confirms that the approach taken by extension matters. The participatory approach featured in Africa RISING’s bi-directional extension system was found to be especially important for farmer adoption of the relatively knowledge-intensive technologies evaluated in this study. The Africa RISING approach was also found to be most effective in promoting farmer adoption of sustainable intensification practices when combined with government extension approaches, which tended to extend consistent extension messages to farmers.

The adoption of pigeon pea – a new crop in the area with favorable soil augmenting potential if combined with appropriate management -- has increased in the group that was exposed to more intensive and possibly reinforcing extension approaches.

We conclude that providing low-risk opportunities for farmers to experiment with new technologies with guidance from researchers and extension agents was an effective approach to disseminate and encourage the adoption of new improved technologies that can increase crop productivity and contribute to sustainable agricultural intensification.

In these study areas of Malawi, farmers in close contact with the traditional public agricultural extension programs were more likely to adopt some new sustainable intensification practices over time, but new adoption tended to be especially favorable when combined with innovative participatory approaches such as Africa RISING. However, the percentage of farmers adopting new sustainable intensification practices over time, while higher for Africa RISING, was quite modest for all groups, suggesting that sustained commitment for participatory extension programs will be needed to promote widespread adoption of improved practices in areas of Africa where most farmers are highly resource-constrained and unable to take major risks.

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