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Irrigation pumps and milling machines as insurance against rainfall and price risks in Nigeria

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The majority of farmers in sub-Saharan Africa (SSA) lack the means to mitigate the impact of risks associated with rainfall and commodity prices due to financial constraints and the imperfect insurance markets in these countries. Because most SSA farmers are risk averse, they may be willing to invest in productive assets that can mitigate the impacts of such risks if their financial constraints are relaxed through external financial assistance. We analyze panel data on investment behavior of Nigerian farmers who received financial assistance for acquiring productive assets. The empirical results show that farmers facing higher rainfall risks are more likely to invest in irrigation pumps that can mitigate the impact of poor rainfall. Similarly, farmers facing the higher price fluctuations for unmilled cassava (*gari*) are more likely to invest in milling machines that enable them to sell milled cassava, an alternative cassava product with a more stable price. Public support for farmers' acquisition of productive assets like irrigation pumps and milling machines will not only enhance their productivity but also help shield them from rainfall and commodity price risks.

Background

Informal risk management strategies play a significant role in reducing the impacts of market and weather related risks for farmers, particularly in developing countries where crop insurance is cost-prohibitive. In an environment susceptible to such risks, investment in productive assets may play a dual role, both increasing agricultural productivity and shielding farmers from risks (Table 1).

Table 1—Dual roles of pumps and milling machines

	Irrigation pump	Milling machine
Raise productivity	Yield increase Value of product	Value of product
Reduce risk	Drought or poorly distributed rains	Crop price fluctuations

Source: Photo of milling machine (UNDP).

With an irrigation pump, farmers can raise land productivity and overcome constraints posed by erratic rainfall. Milling machines enable cassava

farmers to capture high and stable commercial returns by selling cassava flour (milled crop), instead of *gari* (unmilled processed cassava). The price of *gari* is considerably more volatile than that of cassava flour (Figure 1).

Figure 1—Cassava products, *gari* and flour

Prices of *gari*, unmilled processed cassava, are volatile in Nigerian markets. Prices of cassava flour, a substitute for *gari*, are stable. Farmers who invest in milling machines to produce cassava flour reduce their price risks.



Source: Photos (gulfbusiness.tradeholding.com, fiiro-ng.org).

Investment into irrigation pumps or milling machines may be particularly attractive to farmers if other forms of informal risk management strategies are less effective due to their low returns. For example, traditional methods used for production risk management, such as mixed cropping and inter-cropping, often can be safer, but also are often unprofitable. Using these methods to smooth consumption over time can still

be unreliable and will depend on the productivity of the resources farmers own. Investment into other productive assets, such as land or livestock, could realize higher returns, but also remain risky if farmers lack access to sufficient veterinary services or face competitions with other farmers over grazing space.

Using panel data from Nigeria, the research reported here tests whether the risk mitigation motive affects productive asset investments. We consider financial assistance provided to farmers through the Second Fadama Development Project (Fadama II). The project was implemented in Nigeria from 2004 through 2009 with the objective of increasing agricultural productivity through community-driven approaches. A key component of Fadama II was financial support to individual project participants for undertaking investments in productive assets, such as milling machines and irrigation pumps. Since farmers are often constrained in the cash or other financial resources that they require for the purchase of these productive assets, their investment preferences can be revealed when public financial assistance relaxes this financial constraint. By analyzing the effect of financial assistance on their investments in productive assets and characterizing the various risks that farmers face, we examine (1) whether a financial liquidity constraint is influencing farmers' investment decisions, and (2) the types of risks to which their investments respond.

More specifically, this research examines whether the effect of financial assistance was greater in regions with higher rainfall and market price risks. We characterize rainfall and price risks by computing the coefficient of variations of annual rainfall and *gari* prices from regional time-series data. Through this analysis, each region is characterized by levels of rainfall and *gari* price risks. We estimate the marginal effect of financial assistance on investments, taking into account that effects vary based on the magnitude of those risks.

Only a few studies so far have empirically analyzed the risk-mitigating aspects of investments in productive agricultural assets. In addition, this research identifies farmers' ex-ante actions to mitigate income risks, as opposed to ex-post actions, such as consumption smoothing, which have been analyzed by other studies. Without effective ex-post measures including

public assistance, ex-ante actions become potentially very important in risk mitigation.

Data

This study uses a dataset collected for the evaluation of Fadama II. The project was implemented in 120 local government areas (LGAs), or 10 projects in the LGAs in each of 12 states. The Fadama II evaluation collected information from 3,758 farmers, 34 percent of whom were project participants.

Table 2 presents variations in investment behaviors across farmers with different characteristics. In 2006, 7 and 3 percent of farmers in our sample invested in irrigation pumps and milling machines, respectively. Generally, project participants and those who had already owned each productive asset in 2005 were more likely to invest again in 2006. Different investment patterns are observed across genders. Men are more likely to invest in irrigation pumps, while women are more likely to invest in milling machines.

Table 2—Percentage of each type of farmer investing in irrigation pumps and milling machines in 2006

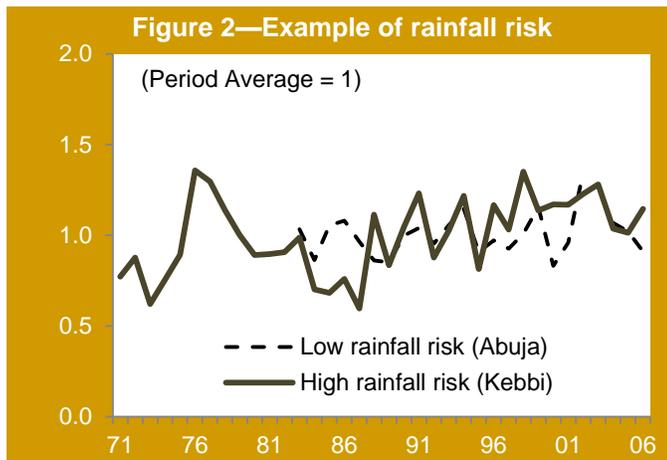
Types	Irrigation pump	Milling machine
All	7	3
Project participant	17	7
Non-participant	2	1
Male	8	2
Female	4	5
Owner in 2005	27	5
Non-owner in 2005	7	3

Source: Authors.

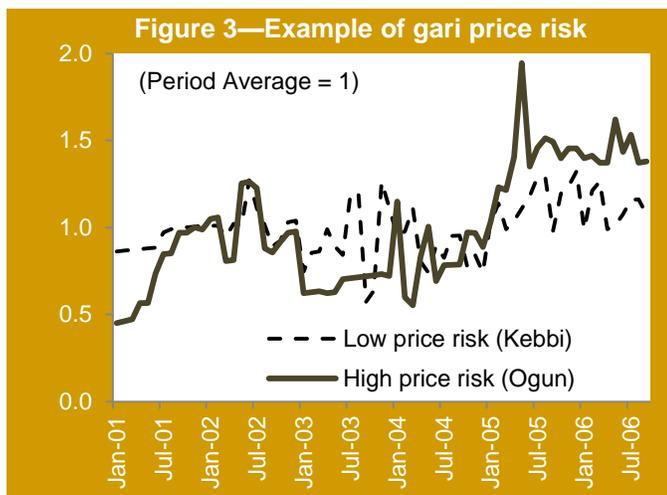
Although previous owners of these machines were aware of the profitability of further investment in these assets, they had been unable to do so due to financial constraints. Across the pool of investors and non-investors, most household characteristics, such as household size, age, and education, are similar. The investors typically belong to low-income impoverished households, as do the other respondents, and live in fairly remote areas from public and market infrastructure.

Figures 2 and 3 illustrate examples of high and low risk trends, based on the coefficient of variations. Table 3 presents the coefficient of variation of annual rainfall and monthly price of white *gari* in selected locations. Based on this

analysis, we categorize the states where Fadama II was implemented into three rainfall risk and two *gari* price risk categories.



Source: Authors' calculation.



Source: Authors' calculation.

Table 3—Coefficient of variation (CV) of annual rainfall and monthly price of white *gari* in selected locations

State	Reference city	Rainfall risk		White <i>gari</i> monthly price (Jan 01 – Sep 05)	
		CV	Group	CV	Group
Adamawa	Yola	0.333	High	0.205	Low
Bauchi	Bauchi	0.166	Medium	0.213	Low
Gombe	Bauchi	0.166	Medium	0.234	Low
Imo	Owerri	0.128	Low	0.241	Low
Kaduna	Kaduna	0.120	Low	0.257	High
Kebbi	Sokoto	0.209	High	0.240	Low
FCT	Abuja	0.095	Low	0.260	High
Lagos	Ikeja	0.165	Medium	0.259	High
Niger	Minna	0.140	Low	0.284	High
Ogun	Ijebu Ode	0.150	Medium	0.323	High
Oyo	Ibadan	0.201	High	0.297	High
Taraba	Yola	0.333	High	0.227	Low

Source: Author's calculation.

Key results

We use two econometric methods, stratified propensity score matching (PSM) and two-stage least square (2SLS) method. Key findings based on PSM are illustrated in Figure 4.

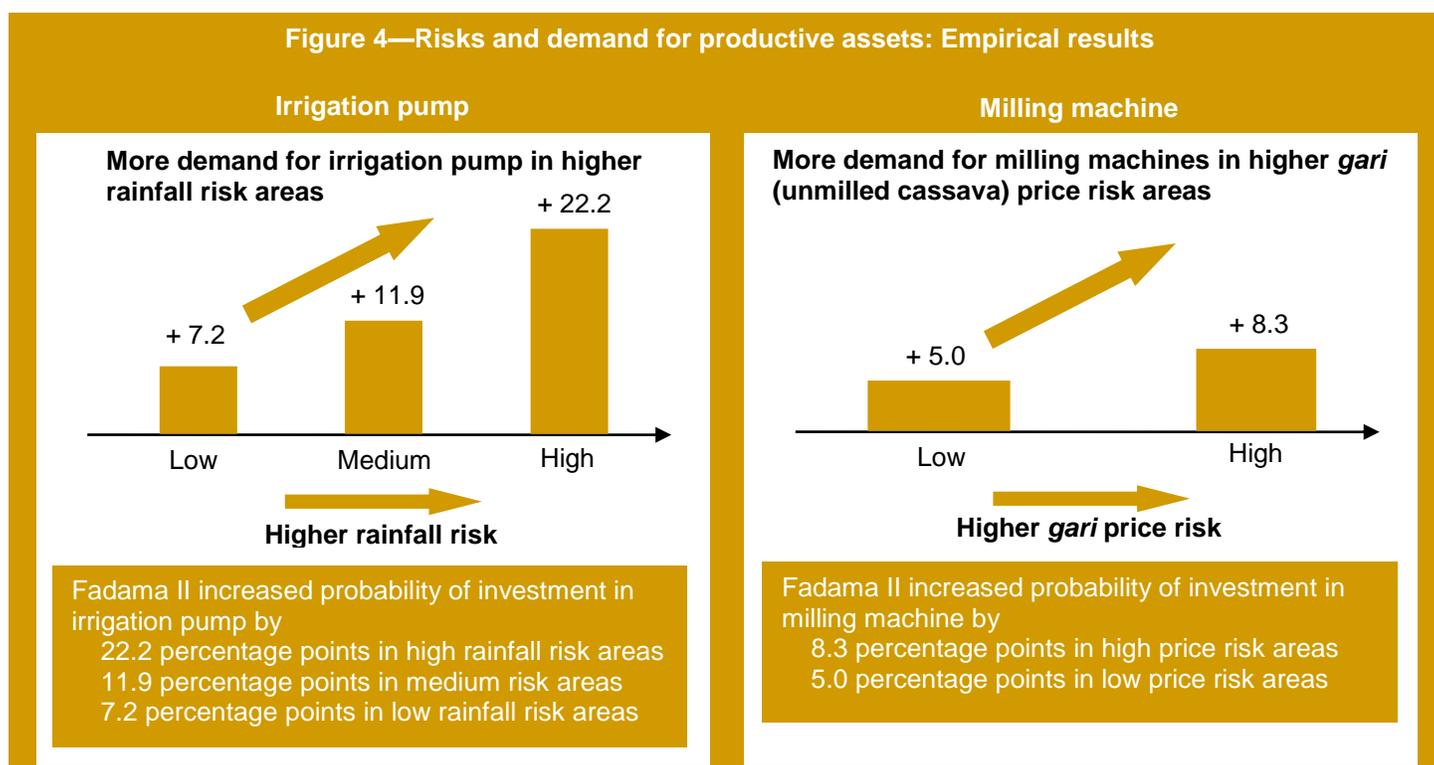
In high rainfall risk areas only 2 percent of farmers outside the project areas invested in irrigation pumps, whereas where the project was implemented, 24.2 percent invested in pumps. Fadama II therefore raised the probability of investment in irrigation pumps by 22.2 percentage points. In contrast, in medium and low rainfall risk areas, such project impact went down to 11.9 and 7.2 percent points, respectively. Similar results are found using the 2SLS method, and the findings are reliable across different assumptions. Fadama II encouraged more investment in irrigation pumps where there is greater risk of poor rainfall and drought. We conclude that Nigerian farmers may be willing to invest in irrigation pumps, not only to raise their farm productivity, but also to insure themselves against this rainfall risk.

In high *gari* price risk areas, while only 1.3 percent invested in milling machines outside of project areas, 9.6 percent invested in such machines where the project was implemented. Fadama II thus raised the probability of investment in milling machines by 8.3 percentage points in high *gari* price areas. In low *gari* price risk areas, project impact went down to 5.0 percentage points. Fadama II encouraged more investment in milling machines in areas where *gari* prices were more volatile. Nigerian farmers may be willing to invest in milling machines to insure themselves against this *gari* price risk.

Conclusion

Productive assets play dual roles in risk-prone agriculture in developing countries like Nigeria, improving productivity as well as insuring against risks. Public support for farmers' acquisition of productive assets like irrigation pumps and milling machines not only enhances their productivity, but also helps shield them from risks associated with poor rainfall and the volatile price of unmilled commodities. The impact of the financial assistance provided by Fadama II needs to be assessed not only on productivity growth, but also by taking into account the additional benefits farmers may derive from reduced exposure to risks.

Figure 4—Risks and demand for productive assets: Empirical results



Source: Authors.

*This policy note is based on the journal article: Takeshima, H. and F. Yamauchi. 2012. Risks and farmers' investment in productive assets in Nigeria. *Agricultural Economics* 43(2): 143-153. <http://dx.doi.org/10.1111/j.1574-0862.2011.00572.x>. Some of the materials in the article have been reproduced in this Policy Note with permission from the [John Wiley & Sons Inc.](http://www.wiley.com)

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