To feed a growing and increasingly urbanized population, Uganda needs to increase crop production without further exhausting available resources. Therefore, smallholder farmers are encouraged to adopt sustainable crop intensification methods such as inorganic fertilizer or hybrid seeds. However, as farmers perceive these new technologies as risky, adoption will depend on how well they can manage this additional risk. This brief documents patterns observed in socioeconomic data that suggest risk is indeed an important barrier to sustainable crop intensification practices among Ugandan smallholder rice and potato farmers. In particular, we find that households that engage in risk management strategies, such as investing in risk-reducing technology or engaging in precautionary savings, are more likely to practice intensified cropping. However, our data also show only limited downside yield risk associated with the use of fertilizers or pesticides, suggesting part of the problem is related to perception. We conclude with some policy options derived from these findings.

Like many low income countries, especially in sub-Saharan Africa, Uganda is an overwhelmingly agrarian society, with 72 percent of the working population engaged in agriculture. Persistently high fertility and rapid urbanization means yields need to increase without further exhausting available resources. Improved access to and use of modern inputs and appropriate technologies, such as synthetic nitrogen fertilizers and high yielding cultivars, together with access to appropriate extension services, is often touted as the best way to increase crop yields.

But farming is an inherently risky business, and it is often argued that the use of such modern inputs exposes poor households to even more risk. Farmers already use a host of risk management and risk coping strategies to deal with risk. Perceived risk associated with the use of modern inputs thus adds to this risk. In light of this, risk avoidance and inability to take on risk may be important to understanding the lack of sustained intensification (Karlan et al. 2014). In this brief, we report on a study in Uganda that explores how risk affects crop intensification among smallholder rice and potato farmers (Van Campenhout et al. 2016).

Between June and August 2014, we collected detailed socioeconomic data from about 880 smallholder farmers in Uganda under the Pasic project. Both the rice and potato sectors are quickly gaining importance in Uganda. Rice and potatoes are non-traditional crops, and thus grown by relatively better off households. This is reflected in our data, especially for rice. Rice growing households in the Eastern region have a few large plots, while potato growing households in the South-western region have many small plots. About one quarter of study households use some kind of fertilizer on at least one of their rice or potato plots. Almost half report using pesticides, herbicides, or fungicides.

IS THERE POTENTIAL FOR INTENSIFICATION?

Figure 1, showing yields of both potatoes and rice in our sample, suggests substantial room for crop intensification. Especially for potatoes, the gap between median and average yields on the one hand, and potential yields on the other hand are huge. We also find that intensification seems to work. Farmers that use intensification technologies that allow them to produce more crops on the same area, such as fertilizer and pesticides, obtain yields that are between 65 and 200 percent higher. We also find that fertilizer and pesticide use is profitable.

DOES INTENSIFICATION INCREASE RISK?

Modern input use not only increases average productivity, it is also likely to increase variance in crop production levels. Put differently, while the use of a certain input may increase the chance that one ends up with a higher quantity of crop produced, it may at the same time increase the chance that one ends up with lower production. Figure 2 shows kernel density estimates of yields for rice in the top panel and potatoes in the bottom panel. The use of fertilizers and pesticides shifts the distribution to the right, thereby...
RISK MANAGEMENT

Farmers are faced with a myriad of risks, which they try to insure against using a host of risk management strategies (Dercon, 2002). Ex-ante risk-management behavior includes private investment in risk reducing technology and infrastructure, such as in storage to reduce post-harvest loss risk. Diversification, where income from different sources is preferred to specialization in production, and income skewing, where low-risk low-return activities or crops are preferred to more profitable but typically also more risky alternatives, are other ways in which households protect themselves. Savings and credit can also provide a cushion when things turn out badly. Obviously, insurance would be the most effective way to protect against risk, but problems related to asymmetric information in local insurance markets appear difficult to overcome.

RISK MANAGEMENT AND INTENSIFICATION IN UGANDA

Using the data from the potato and rice farmers in Uganda, we investigate if farmers that use risk management strategies are more likely to use fertilizer or pesticides. We first look at private investments in risk reducing technologies. One source of uncertainty for farmers is price risk. Spatial price risk, stemming from uncertainty about the price in consumer markets, can be mitigated by reducing search costs. Recent research has looked at the potential of Information and Communication Technologies (ICTs), especially in the form of mobile phones, to reduce risk emanating from information market inefficiencies (Nakasone et al. 2014).

The two stacked bar charts on the left in Figure 3 look at the relation between private investment in information gathering technology and intensification behavior. About 45 percent of household that report having a mobile phone do not use fertilizer or pesticides. Among the households that do not own a mobile phone, however, this is more than 60 percent. At the same time, the share of farmers that uses both pesticides and herbicides is almost three times as large among mobile phone owners as among non-mobile phone owners.

Farmers can also invest in improved storage facilities to reduce risk of post-harvest losses. We asked farmers whether they store their potatoes or rice in a special storage facility, as opposed to just on the floor. About 45 percent of households that have improved storage are not using any improved inputs. However, this
share is significantly higher at 64 percent for households that have no improved storage (Figure 3, right panel).

**Diversification** is a very important risk management strategy that is used by individuals and households in risky environments. More than 60 percent of households in our sample report to be growing 3 or 4 crops in addition to the potato or rice crops that they grow. Using a measure that also incorporates the relative importance of each crop in the crop mix, we find that rice and potato farmers grow a moderately diversified crop mix. We then relate these indicators of diversification to sustainable intensification practices. The first panel in Figure 4 explores the relation between fertilizer use and the number of crops the household grows. The red line indicates that, overall, about 25 percent of households report using fertilizer. However, this proportion seems to be higher for households that grow more than four crops. The second panel is similar, but looks at the use of pesticides. Here we see that about 43 percent of households are using pesticides/fungicides or herbicides. We again find that households that have only one or two crops next to potatoes or rice are less likely to be using pesticides. Overall, the evidence is consistent with a situation where households that are better able to protect themselves against bad luck through diversification are also more likely to engage in intensification.

**Figure 4: Diversification in crop production, based on use of fertilizer or pesticides**

In the absence of credit and insurance markets, **precautionary savings**, often in the form of non-financial assets such as livestock, is probably the most effective way to protect against common shocks (Deaton, 1991). Figure 5 explores the link between savings in livestock assets and sustainable crop intensification among Ugandan potato and rice farmers. The figure plots a non-parametric regression curve and shows that the proportion of households that use fertilizer increases gradually, from virtually zero to about 30 percent, over a range of livestock assets between 0 and UGX 500,000. For pesticides, there is a similar increase from about 20 to 45 percent. Once a household has more than UGX 500,000 in livestock assets, the proportions seem to level out. From this we conclude that households that have more livestock are more likely to intensify.

**Figure 5: Association between precautionary savings in the form of value of livestock owned and fertilizer or pesticide use**

**POLICY RECOMMENDATIONS**

Since agricultural risks are interrelated and farmers are managing risk through a system of interrelated strategies, agricultural risk management policies should take a holistic approach. While some policies or interventions may crowd out other risk management strategies, others may reinforce each other. Bearing this in mind, we propose a comprehensive agricultural risk management policy that should pay attention to the following components:

- **Calamity insurance and social safety net**: Large shocks that affect entire areas are difficult to insure against and can have large and lasting consequences. Governments should be ready to deal with disasters and may temporarily need to support livestock markets and provide emergency aid.
- **Promote development of risk insurance markets**: The government should create an environment in which a private market to insure against normal risk can develop and flourish. Since risk reducing instrument such as commodity futures and weather insurance are contract based, strong institutions are very important.
- **Agricultural price risk management**: The government’s first concern should be to increase the pass-through of prices. Therefore, policy makers should design policies that are likely to improve connections between remote villages and the world market. Limited price intervention may be justified for cases where market failures are responsible for the bulk price uncertainty.
• **Risk reducing public investments**: Just as individuals and households can invest in risk reducing technologies, governments can engage in the provision of public goods that are more or less likely to affect agricultural risk.

• **Contract farming**: Contract farming can be a very good way to mitigate risk related to innovation in agriculture. The development of Zonal Investment Plans (ZIPs) within PASIC, which aim to develop investment blueprints showcasing investment opportunities in different zones in Uganda and public-private partnership is likely to increase smallholder outgrowing schemes.

• **Change farmer’s perceptions**: Educate farmers about the risks associated with intensification. Design and test policies and instruments that, through positive reinforcement and indirect suggestion, guide farmers to take up more risk.

**References**


