

BUNDLING INNOVATIVE RISK MANAGEMENT TECHNOLOGIES TO IMPROVE NUTRITIONAL OUTCOMES OF VULNERABLE AGRICULTURAL HOUSEHOLDS

BY MICHAEL CARTER (MRCARTER@UCDAVIS.EDU), TRAVIS LYBBERT, STEPHEN BOUCHER

How can agricultural development interventions be designed to improve nutritional outcomes in farm families and communities as a whole? Most often, this question has been approached by considering interventions or technologies that will, in a typical year, increase the local availability of nutritionally dense foods, or increase the incomes of rural families. In this study, researchers will instead consider the nutritional impact of scaling up “stress-resistant” agricultural technologies that are designed to stabilize production and incomes in atypical or bad crop years.

First and foremost, this approach should reduce the human development losses that occur during periods of drought and other types of climatic stress that reduce incomes for both farm and landless labor families. Second, stress-resistant technologies pay a further “risk-reduction dividend,” inducing behavioral change on the part of producers who intensify production, raising incomes and food availability levels in average, non-stress years. It is the goal of this study to determine if stress-resistant technologies are a cost-effective approach to meeting nutrition and health goals.



Maize farmer in East Africa, Photo Credit : Emilia Tjernström

The Human Cost of Climate Stress

Myriad research has identified the human costs of climatic stress such as drought, including maternal BMI declines, slow growth rates among children, and – in the case of young children – severely damaged long-term cognitive development. In fact, the average impacts of drought on stunting are primarily driven by impacts in the poorest households; the impact of drought on children in these households is fifty percent more severe than the estimated average effect.

Additional research has considered how households cope with drought stress. This work often finds that relatively better-off households almost completely insulate consumption from drought shock by selling off or drawing down assets that are equal in value to almost 90 percent of drought related losses. In contrast, poorer households smooth away less than half of the shock, leaving the bulk of the shock to be absorbed as decreased consumption. In order to avoid increasing their future vulnerability, these poorer households commonly choose to hold on to their scare assets rather than sell them off to smooth consumption.

Unfortunately, this asset protection strategy can have costly intergenerational consequences as current consumption and nutrition shortfalls may reduce the future human capital accumulation of the youngest household members. It is

www.feedthefuture.gov



USAID
FROM THE AMERICAN PEOPLE



this linkage to the future that makes it so important to pursue stress-resistant strategies that insulate households' income from climatic shocks.

Combining Agricultural and Financial Innovations

Recent years have seen the separate development of two technologies designed to help small-scale farmers manage climatic stress. The first technology is seed varieties that better withstand climatic stresses like droughts and floods. The second is the financial technology of index insurance that transfers risk out of small-scale farming systems by issuing compensatory payments when climatic events occur and agricultural production collapses. These two technologies work in a similar way, but some important differences create a potential complementarity between the two.

Potential for Complementarity

- Both stress-resistant seeds and insurance are designed to stabilize producer incomes in the wake of an adverse event.
- Both seed and financial technologies have the potential to generate a risk reduction dividend as farmers with these risk management tools may invest more heavily in their farms.
- While insurance payments generally increase as stress conditions become more severe, protecting against moderate stress with insurance can be very expensive – and this moderate stress protection may be more cost effectively provided by stress-resistant seeds.

Both stress-resistant seeds and insurance are designed to stabilize producer incomes in the wake of an adverse event. For example, a recent study of the impact of a flood tolerant rice variety in India showed that yields were 25 percent higher on flood-stricken fields with the new seeds than those without. Similarly, a recent study showed that after a severe drought in Northern Kenya, poorer households that received an index insurance payout were significantly less likely to rely on reduced food consumption as a coping strategy compared to uninsured households. In addition to their common ability to stabilize producer incomes in the face of shocks, both seed and financial technologies have the potential to generate a risk reduction dividend as farmers with these risk management tools may invest more heavily in their farms.

Yet, these technologies also have important differences. Most importantly, stress-resistant seeds tend to fail under extremely adverse events, whereas index insurance does not. For example, the flood resistant rice varieties can survive up to 17 days of flood-induced submergence, but beyond 17 days die and yield nothing (just like conventional rice varieties). While insurance payments generally increase as stress conditions become more severe, protecting against moderate stress with insurance can be very expensive – and this moderate stress protection may be more cost effectively provided by stress-resistant seeds. This creates a natural complementarity between the seed and financial technologies.

The Learning Opportunity

While the work to date on these new technologies is encouraging, it has neither explored their complementarities, nor has it traced out their impacts on nutrition. With new drought tolerant (DT) maize varieties ready to go to market, and with our growing knowledge of how to design effective insurance products for small-scale agriculture, now is an opportune moment to close this critical knowledge gap.

Charged with reducing vulnerability and improving food security, the Drought Tolerant Maize for Africa (DTMA) project has developed over 140 DT maize varieties that have been field-tested and are now beginning to reach farmers. DT field

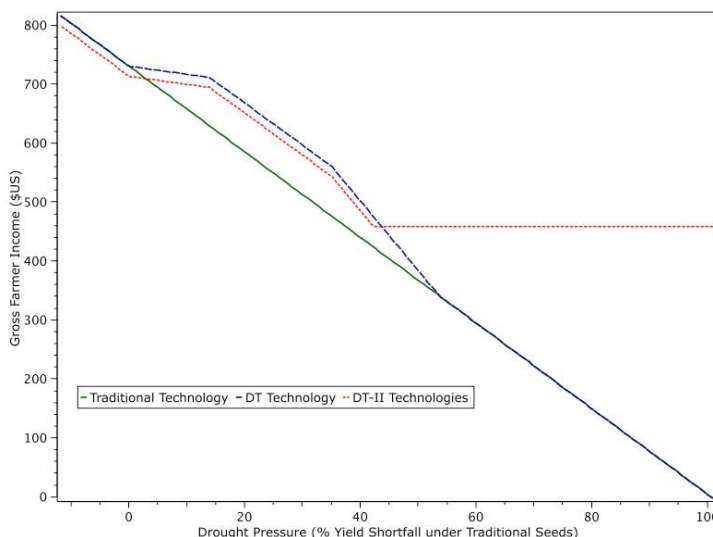
trial data reveal impressive results overall. However, under extreme drought conditions (which may occur as much as 20 percent of the time in some African maize-growing regions), new DT varieties, like conventional varieties, fail. It is under these conditions that novel financial technologies, like index insurance, can potentially complement and deepen the impact of DT seed technologies on the livelihood prospects and reduce the vulnerability of poor farmers.

This study will explore the determinants of uptake and measure the impacts on on-farm investment levels and nutritional outcomes of DT varieties alone and bundled with a complementary insurance product.

How Will the Bundled Technology Work?

To illustrate the core idea behind the bundle, BASIS researchers simulated how different risk-reducing technologies might work using existing data from a drought-prone region of Ecuador.

The solid green 45-degree line in Figure 1 (right) graphs farmer income as a function of the yield shortfall under the traditional technology and thus represents a benchmark prior to the introduction of the new technologies. The dashed blue line displays the expected impact of introducing DT varieties and is consistent with the results of field trials conducted by CIMMYT in several countries in Sub-Saharan Africa. Under moderate drought pressure in which yields under the traditional technology fall up to 15%, the DT technology stabilizes yields at nearly their long-term expected average (\$730/ha). In this simulation, there is a 15% probability of this type of moderate drought pressure under which DT seeds offer powerful protection against drought stress.



As drought pressure increases, and the yield shortfall under traditional seeds increases from 15 to 35% of the long-term average, DT yields also begin to slowly decline under the stress, reaching a “red zone” of failure. As drought pressure further increases, yields fall to 55 percent or less of their long-term average. In this simulation based on Ecuador, this severe drought pressure occurs 10 percent of the time. At this point, the advantages of DT begin to disappear. In Ecuador, DT technology offers modest to strong protection for 80 percent of all drought events. However, for the 20 percent of events that are most extreme, that advantage dissipates, creating the space and need for a complementary stress-resistant technology. The occurrence of extreme conditions is expected to be higher in Africa, and as such the fraction of drought events managed by DT will be smaller.

Figure 1 displays what further benefits could be achieved with an index insurance contract that kicks in and stabilizes farmer income at those higher drought pressure levels where DT varieties lose their efficacy. The dotted red line displays how a “red-zone index insurance contract” would work. In this example, the insurance kicks in and stabilizes farmer income when yield shortfalls reach 40%, which is the level when DT varieties lose their ability to protect the farmer. Under this combined mechanism, farmer income never falls below the level associated with a drought that reduced yields by 40 percent, no matter how severe drought pressure becomes.

The Study

This study will seek to answer three main questions:

1. Can stress-resistant agricultural technologies improve nutrition and human development in vulnerable populations?
- 2.
3. Given evidence that the impacts of income or purchasing power alone on nutritional outcomes can be weak on average, are these impacts amplified when women enjoy a stronger intra-household bargaining position?
4. Does the provision of an index insurance contract that manages extreme drought events where DT seeds fail improve the uptake and strengthen the impact of a stress-resistant seed technology?

Study participants will be divided into three groups: a group that serves as a pure control and receives no intervention, a group that receives only improved seed varieties, and a group that receives improved seed varieties bundled with index insurance.

This study will be conducted in Tanzania and Mozambique in collaboration with CIMMYT and DTMA. Working with these organizations, BASIS researchers sought out three characteristics in identifying these target countries: (i) Strong seed company partners, (ii) Locations where maize is an important part of the basic diet and maize production is central to households' livelihood strategies, and (iii) Spatial and climatic variation across the study area to increase the probability of observing drought events within the four years of the study. Tanzania has the second largest area in Africa planted to maize (second only to Nigeria), making this country selection particularly important for the study. Tanzania also has substantial unmet potential. Mozambique, like Tanzania, is a promising area for the study, as existing maize yields are quite modest, meaning that the expected impacts of the proposed technologies should be quite large.

Policy Implications

This research will speak to the global discussion about the wisdom of investing in agriculture as a mechanism not just to produce more food, but as a cost-effective mechanism to address under-nutrition. In looking specifically at investments in stress resistant technologies, this work – if it indeed finds that investments in stress resistance is effective – will offer a new and important perspective on how governments, aid agencies, foundations and other donors should shape their investment strategies.

More specifically, the evaluations of the interventions proposed in this study may have important implications for the design of programs and policies in rain fed maize regions of Sub-Saharan Africa. If bundling DT maize varieties with index insurance has the anticipated effects on nutrition and household income resilience, the project will provide a way to extend the reach of DTMA investments by making the DT maize portfolio relevant for even marginal maize regions.

Additional Reading

Carter, Michael R., Alain de Janvry, Elisabeth Sadoulet and Alexandros Sarris (2014). "Index-based Weather Insurance for Developing Countries: A Review of Evidence and Propositions for Scaling-up," *FERDI Working paper*.

Hoddinott, John and William Kinsey (2001). "Child Growth in the Time of Drought," *Oxford Bulletin of Economics and Statistics* 64: 409-36.

Lybbert, Travis and Michael R Carter (2014). "Bundling Drought Tolerance and Index Insurance to Reduce Rural Household Vulnerability to Drought," in *Risk, Resources and Development: Foundations of Public Policy* (Elsevier Press).