RESEARCH HIGHLIGHTS

Long-Range Forecasts as Climate Adaptation: Experimental Evidence from Developing-Country Agriculture

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Can access to better forecasts help farmers better adapt to climate change?

Context

Climate change is making weather more variable, with rainfall patterns becoming less predictable and extreme temperatures occurring more frequently. Agriculture is particularly sensitive to these changing conditions, jeopardizing the livelihoods of the 67 percent of the world's poor who depend on agriculture for survival. Effectively coping with this variability will be essential as the world continues to warm: Highly variable weather makes it challenging for farmers to tailor their planting decisions to the coming season, leading them to underinvest in things that could increase their profits like high-yielding crops, fertilizer, labor, and more. By giving farmers a preview of the conditions of the coming growing season, accurate long-range forecasts have the potential to help farmers make the best possible investments. This study presents the first experimental evidence on the impact of such an accurate long-range monsoon forecast—a new climate adaptation technology—on farmers' behavior and well-being.

Research Design

The researchers study a forecast of one key piece of information for Indian farmers: the timing of the onset of the Indian Summer Monsoon. Despite the fact that nearly two-thirds of the global population live in monsoon-affected regions, predicting when monsoons will arrive has remained elusive. To test whether information about the onset of the monsoon would change farmers' behaviors, the researchers used a new monsoon forecast developed by the Potsdam Institute for Climate Impact Research, one of the only forecasts able to accurately predict monsoon arrival more than a month before onset.

Specifically, the researchers studied 250 villages in Telangana state in Southern India, where more than half the labor force are farmers. To test the impact of forecast information on farming, the researchers randomly assigned the 250 villages to three groups: a group that receives forecast information at least one month in advance of the monsoon season, a comparison group that does not receive the forecast, and a group that receives insurance (used as a benchmark). They tracked how the forecast information impacts the farmers' beliefs about the monsoon onset pre-harvest, their up-front investment decisions, their well-being at the end of the growing season, and how their behavior compares to those who received the insurance.

> "Farmers tailor their planting decisions based on what they think the weather—and in many parts of the world, the monsoon—will be like, but climate change is making the monsoon and other weather patterns increasingly difficult to predict. Our study, from an Indian state where agricultural productivity per worker is generally low, found that new forecasts are able to deliver accurate monsoon predictions even in a changing climate. Farmers listen to these forecasts and are able to change their planting decisions accordingly, making them an important climate adaptation tool for the agricultural sector."
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Findings

Farmers disagree widely about when the monsoon will start, highlighting the need for forecasts. Though monsoon onset timing is extremely important for agriculture, most farmers do not have access to accurate onset information. The vast majority of farmers in the study were getting their information from other farmers, with only a small minority relying on the government or other services for information on when the monsoon would begin.

The researchers first measured farmers' own predictions about when the monsoon would begin before providing the forecast information. During this initial visit, the farmers' predictions varied widely, even within villages. The more optimistic farmers believed the monsoon would come about 2.5 weeks earlier than the more pessimistic farmers. The stakes are high: An earlier monsoon typically means a longer growing season, suited to cash crops like cotton, while later monsoons are generally worse, forcing farmers to grow lower-value subsistence crops.

Farmers are persuaded by forecasts and find them valuable. In the year the researchers studied, the forecast predicted an average monsoon. As a result, around a third of the farmers' initial beliefs turned out to be overly pessimistic. The forecast brought these farmers the "good news" that the monsoon/growing season would be longer than they had originally thought. Conversely, a third of the farmers' initial beliefs were overly optimistic and received "bad news" from the forecast: The growing season would be shorter than they expected. The final third of farmers had initial beliefs that turned out to be correct.

After the researchers provided the forecast, they returned to the farmers to see if their beliefs had changed after being told the forecast information. In this visit, they found strong evidence that the farmers changed their beliefs to be more in line with the forecast. Moreover, the farmers showed that they highly valued this information: They were willing to pay as much for the forecast as for an insurance product that pays out approximately 20 percent of average crop revenue under a late monsoon.

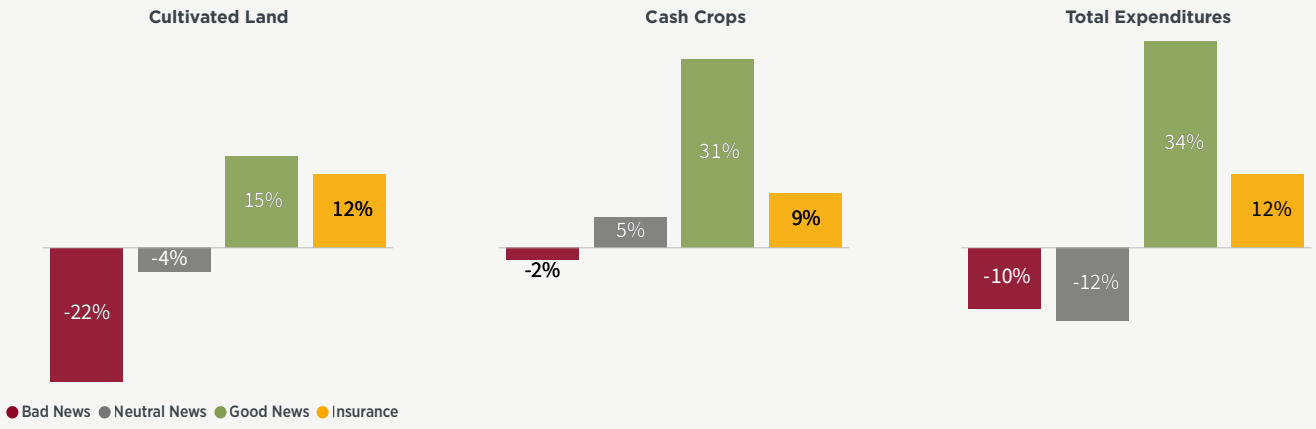
Farmers change their farming behaviors according to the forecasts. The forecast went beyond changing beliefs and had large impacts on the farmers' behaviors. Overly optimistic farmers, for whom the forecast was "bad news" of a shorter-than-expected growing season, took steps to cut down on investments by reducing the amount of land they cultivated by 22 percent and were 32 percent less likely to add a new crop. They also reduced their expenditures by 10 percent—driven largely by cutting the amount of fertilizer they bought by 30 percent.

On the other hand, overly pessimistic farmers, for whom the forecast was "good news" that the growing season would be longer than expected, increased investments and expenditures. They increased the land they cultivated by 15 percent, were 14 percent more likely to add a new crop and 16 percent more likely to plant cash crops. They spent over a third more on up-front investments in total.

Changes in agricultural investments lead to changes in agricultural outcomes and well-being. Overly optimistic farmers who received "bad news" and reduced their farming investments saw their agricultural output and sales decline by 27 percent and 20 percent, respectively. Their agricultural profits also declined. However, these farmers tended to find other ways to make money (these farmers were 36% more likely than the control group to own a non-agricultural business) and cut their debt in half, leading to an increase in net savings of more than $560 per farmer—more than 10% of total income. They also increased their business profits by 47 percent. Together, these results imply that the forecast likely made these farmers better off: Instead of doing unprofitable farming, they were able to diversify their activities.

In contrast, the forecast caused overly pessimistic farmers to do more farming. This led to 22 percent increases in agricultural production but did not qualitatively impact profits on average. The forecasts also appear to have benefited the poor the most: Farmers who were less well off at the beginning of the study had the largest increase in profits as a result of receiving the forecast.

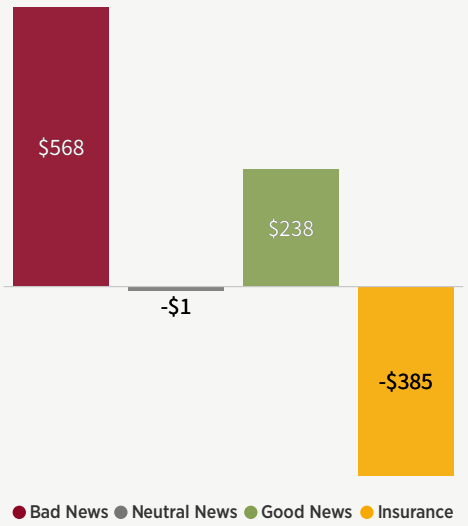
Figure 1 · Farmer Responses



Note: Effects are relative to farmers with the same beliefs as in the control group. They are in percent of their control group means.

Insurance encourages optimistic farmers to invest more but does not guide smarter choices. While accurate forecasts inform farmers about what is coming, allowing them to tailor investments to the growing season conditions, agricultural insurance—a widespread policy around the globe—lowers farmers' risk exposure, but does not improve their information. Overall, farmers who received insurance increased the land they cultivated and the amount they spent on up-front investments like seeds and fertilizer by 12 percent compared to those who did not receive forecast information. This was driven by overly-optimistic farmers, who incorrectly believed it would be a bet-ter-than average year. Given the safety net the insurance provided, they responded with a large increase in investments—even though the forecast would have caused them to instead reduce invest-ments. On the other hand, overly pessimistic farmers for whom the forecast would have been "good news" did not meaningfully change their investments (though it would likely have been beneficial to do so) despite having the insurance. These findings underscore the fundamental differences between insurance and forecasts and sug-gest that they could be used as complimentary climate adaptation strategies: Forecasts let farmers make the right investments for the coming year, while insurance protects farmers against downside risk.

Figure 2 · Net Savings



Note: Effects are relative to farmers with the same beliefs as in the control group.

CLOSING TAKE-AWAY

Long-range forecasts enable farmers to make the best possible decisions about whether to plant at all, how much to plant, what to plant, and how to make adjustments across crops by providing critical information about the coming growing season. As such, providing farmers with better access to forecasts can help them adapt to the less predictable conditions that come with climate change. However, forecasts with proven accuracy are rare and often inaccessible. Improving forecasts and making them available to farmers could increase the wellbeing of farmers and boost the economies of farming communities around the world.

The Energy Policy Institute at the University of Chicago (EPIC) is confronting the global energy challenge by working to ensure that energy markets provide access to reliable, affordable energy, while limiting environmental and social damages. We do this using a unique interdisciplinary approach that translates robust, data-driven research into realworld impacts through strategic outreach and training for the next generation of global energy leaders.