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New modalities for managing drought risk in rainfed agriculture: Evidence from a discrete choice experiment in Odisha, India

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ABSTRACT

Droughts have historically had large impacts on agricultural production in rainfed agricultural systems. Scientists and policymakers have proposed various strategies for managing risks, with limited success. In this study we consider two such strategies, specifically drought tolerant rice and weather index insurance. While neither drought tolerant cultivars nor weather index insurance products are perfect solutions for adequately managing drought risk in and of themselves, there is scope to exploit the benefits of each and bundle them into a complementary risk management product, specifically through proper index calibration and an optimized insurance design. In this study, we explore preferences for such a complementary risk management product using discrete choice experiments in Odisha, India. We are able to estimate the added value that farmers perceive in the bundled product above and beyond the value associated with each of the independent products. We also show that valuations are very sensitive to the basis risk implied by the insurance product, with farmers less enthusiastic about risk management products that leave significant risks uninsured.

1. Introduction

In rainfed rice production systems throughout India, agricultural activities are intimately tied to the arrival and departure of the summer monsoon, and any aberration in monsoon rainfall can have disastrous consequences on foodgrain production, with subsequent impacts on food security and rural livelihoods. Evidence seems to suggest that Indian agriculture may be in the midst of a transition to a new monsoon normal: in five of the last six years, monsoon rains have been weak and unevenly distributed over both time and space, and three of the seven years from 2009 through 2015 have been officially designated as all-India drought years. Total rice production has suffered as a result of these vagaries in monsoon rainfall, both as a result of decreases in harvested area as well as through reductions in rice yields. Many farmers prepare nurseries only after the arrival of the first rains, so any delay in the monsoon onset can result in reductions in total area under cultivation and potentially lower yields. Early monsoon cessation, similarly, can have significant impacts on total rice production, reducing yields due to limited hydration during a critical period in the plants' development. In addition to these effects arising due to monsoon timing, intermittent, prolonged dry spells during the season can also significantly affect productivity. The drought experienced in 2014 was not as severe as droughts in, for example, 2002 or 2009, yet estimated losses in India were around $30 billion, with national GDP consequently decreasing by about 1.7 percent.

These production effects of drought risk are certainly the most visible effects that droughts impose on Indian agriculture. But in addition to these obvious effects, it is possible that the most substantial effect of droughts in constraining agricultural production in rainfed ecosystems may be through its effect in reducing farmers' investments in higher risk – higher return activities, such as higher yielding seed varieties and hybrids, using chemical fertilizers, using other crop protection chemicals (e.g., pesticides, herbicides, etc.) and investing in irrigation. In this regard, drought risk can be seen as imposing both ex post as well as ex ante impacts: the ex post impacts are the more visible effects that are only realized after a drought has been experienced; the ex ante impacts are those that are not visible, arising due to merely the threat of drought, but which nonetheless are very real and have sustained impacts. Elbers, Gunning, and Kinsey (2007), for example, suggest that, in sum, combined ex ante and ex post drought risk effects

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reduce long-term capital accumulation by as much as 46 percent, but nearly two-thirds of this reduction can be attributable to these sorts of ex ante effects. Lybbert and Carter (2014), in turn, refer to droughts as being like "a bully," where the specter of drought looms over farmers' heads and compels them to make decisions or take actions that might otherwise be neither rational nor optimal.

The state of Odisha, in eastern India, is often regarded as India's 'disaster capital' owing to the frequency with which it has been victim to droughts, floods, and cyclones over the years. In the 108-year period from 1900 to 2007, Odisha suffered from drought in 39 of those years (Annual Report 2006–7, Government of Odisha). Farmers' dependency on erratic rainfall in the absence of adequate irrigation facilities has made them extremely vulnerable to the negative ex post impacts of droughts. Pandey, Bhandari, and Hardy (2007) report some of the negative consequences of droughts in Odisha: a 33 percent reduction in gross cropped area and cropping intensity, including a 41 percent reduction in rice area; a 60 percent reduction in rice production; and total income losses of 26 percent. Small and marginal farmers, who constitute the bulk of farmers in Odisha, are often hit the hardest. In addition to these ex post losses from drought, there are significant ex ante losses resulting from drought risk. UNDP (2003) estimates indicate that Odisha faces deficient rainfall (75 percent of normal or less), on average, once in five years. "Knowing that droughts are regular phenomena that cannot be predicted accurately, farmers would have evolved conservative practices that give them some safety even though such practices may result in income losses during normal years" (Pandey et al., 2007, p. 39). Identifying effective means with which to protect farmers from both ex post and ex ante effects of drought risk remains an important objective, both in terms of government policy as well as broader economic and human development.

There are many instruments that can be leveraged to address drought risk. One such intervention involves the breeding of cultivars for drought tolerance and short duration. There has been a great deal of interest within the international donor and agricultural research communities in support of these efforts. In particular, the Stress-Tolerant Rice for Africa and South Asia (STRASA) project, with support from the Bill and Melinda Gates Foundation, has made significant progress in the development of rice varieties tolerant to several different types of abiotic stresses, including droughts, floods, and salinity. The International Rice Research Institute (IRRI), in collaboration with national research partners, has led efforts for developing drought-tolerant (DT) rice varieties suitable for cultivation in drought-prone areas of India, and in 2010 released a DT rice variety (Sahbhagi dhan) for cultivation in Jharkhand, West Bengal, Bihar, and Odisha in eastern India. In experimental trials, this variety has been shown to give better yields over comparison varieties under certain drought stress conditions (Verulkar et al., 2010). Since the variety is still quite new, however, there is still much to be learned about how this variety performs in farmers' fields.

In what follows, we will assume the following stylized, qualitative characterization of DT yield benefits (c.f. Lybbert & Carter, 2014). Under normal (or irrigated) conditions, there is essentially no yield advantage relative to other commonly grown varieties and indeed may, relative to some high yielding long duration varieties, suffer from a modest yield penalty. Under moderate drought stress, however, the DT variety begins to exhibit yield benefits relative to the non-DT varieties. While absolute yields are still lower than they would be under normal or irrigated conditions, the reduction in yields is considerably less than those observed among the non-DT varieties under the same conditions. In this drought stress region, there are positive and increasing relative benefits associated with DT. Once the drought becomes severe, however, the relative benefits of DT – though still positive – begin to decline.[1] In other words, while DT yields are still higher than non-DT, the magnitude of the yield advantage is diminishing. Once the drought becomes extreme, the relative benefits of DT are exhausted, and DT is virtually indistinguishable from non-DT. In this region, it can be assumed that both DT and non-DT crops would fail, or would yield so little as to not even justify harvesting. Sahbhagi dhan is also a short duration variety, flowering as quickly as 70–80 days after transplanting and reaching full maturity in less than 100 days after transplanting. This short duration provides a means of escaping either early or late season droughts, for example, arising from delayed monsoon onset or early monsoon cessation.

An alternative intervention that could be used to address drought risk is through providing farmers with insurance. Unlike DT, which primarily addresses ex post drought impacts, insurance is a risk transferal mechanism that helps remove some of the ex ante drought risk burdens. Agricultural insurance, specifically insurance against crop loss, has been around for many years, even in developing countries like India. Pilot crop insurance programs implemented since 1972–73 led to the first major government crop insurance program in 1985–86, the Comprehensive Crop Insurance Scheme (CCIS) that was subsequently replaced by the improved National Agricultural Insurance Scheme (NAIS) in 1999–2000 (Nair, 2010a; Sinha, 2004). These programs used an "area approach", whereby insurance payouts are made to all farmers in an area where average yields fall below the guaranteed yield (Nair, 2010a). Despite having several national-level programs to promote insurance, however, only about 20 percent of gross cropped area was covered under various insurance schemes as recently as 2014. 2016 saw the launch of the Pradhan Manti Fasal Bima Yojana (PMFBY) which replaced the NAIS.

There are several problems with most of the insurance programs that have been implemented thus far, even the index-based insurance programs. First and foremost is that insurance is typically significantly more expensive than farmers are willing to pay. The cost of insurance factors in not only the risk and magnitude of potential losses, but also administrative loads to compensate for the cost incurred by the insurers in assessing losses as well as risk loads, which are typically higher for agricultural insurance due to the highly covariate nature of the risks being insured against. But the low demand for insurance is not unique to developing countries: even in many developed countries, farmers are typically unwilling to purchase unsubsidized insurance. The subsidies, however, typically impose significant fiscal burdens.

Another problem with traditional crop insurance is that it is susceptible to informational asymmetries, resulting in adverse selection and moral hazard. Weather index insurance (WII) has been promoted as an alternative to traditional indemnity-based agricultural insurance (e.g., Alderman & Haque, 2007), and has gained popularity among development practitioners and researchers in recent years. In the case of WII, the payouts are based on realizations of a specific weather parameter measured over a pre-specified period of time at a particular weather station (World Bank, 2011). Since payouts are ascertained by exogenous information independent of unobservable household characteristics or ex post household decisions (Giné, Townsend, & Vickery, 2008; Karlan & Morduch, 2009; Morduch, 2006), WII partly addresses the problems of moral hazard and adverse selection, as

[1] In one of the only known experiments studying the relative performance of Sahbhagi dhan and other varieties under drought conditions, Verulkar et al. (2010) suggest that the yield benefits of Sahbhagi dhan relative to other popular varieties persist even under severe drought conditions. We conservatively assume that such relative benefits may accrue on experimental stations, but may not translate onto farmers' fields. We therefore maintain the assumption of declining relative yield benefits under severe drought stress conditions.