CSISA Research Note 5

Farmer Preferences for Drought Tolerance in Inbred and Hybrid Rice: Evidence from Bihar, India

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The Cereal Systems Initiative for South Asia (CSISA) is a research-for-development partnership implemented jointly by five CGIAR institutions – the International Maize and Wheat Improvement Center (CIMMYT), International Food Policy Research Institute (IFPRI), International Livestock Research Institute (ILRI), International Rice Research Institute (IRRI) and World Fish – in close partnership with public and private sector organizations across South Asia.

Introduction

Droughts are a significant constraint to rice production in most of India; 16 million hectares of rain-fed lowland rice and over six million hectares of upland rice are prone to drought. The yield losses and reduction in area planted resulting from droughts have obvious implications for India's food security and for the livelihoods and well-being of farmers and their families.

Plant breeders in India and elsewhere have developed drought-tolerant (DT) rice cultivars that yield at least as well as traditional, non-DT cultivars under normal conditions but yield better than the traditional cultivars under drought stress. Most rice breeding in India is conducted by the public sector, e.g. state agricultural universities or institutes of the Indian Council of Agricultural Research, producing inbred cultivars that are distributed through various channels to small-scale and resource-poor farmers. The benefits of inbred cultivars include that the seed is cheap to produce and farmers can save seed to replant in the following season, reducing their production costs. The private sector is less involved in rice breeding. Where it is involved, private sector firms, e.g. seed companies, commonly develop hybrids rather than inbred cultivars. Hybrid rice commonly out-yields inbred cultivars by 10 to 30 percent under irrigation in Bangladesh, China and India, but hybrids deliver their full benefits only in the first year they are planted – seed saved from this crop delivers variable results, meaning that farmers must buy new seed every season. This has obvious benefits for the firms breeding the hybrids and producing and selling the seed, but has cost implications for the farmer.

Methodology and Objectives

This study[1] used experimental choice modeling to examine farmers' preferences for inbred and hybrid cultivars with a range of DT characteristics and to explore how these

preferences differ among farmers, grouping farmers into 'classes' with similar underlying characteristics[2]. This classification is useful in identifying possible market sectors.

The study sample consisted of 475 rice-producing households in three districts in Bihar state that are heavily dependent on rice production – Bhojpur, Madhubani and Nawada. These three districts provide a great deal of heterogeneity, not least in geography and agroecology.

Farmers were asked to choose among hypothetical rice cultivars that differed in characters that influence farmers' choice of cultivars: length of growing season, yield under normal conditions and under moderate and extreme drought stress, whether or not grain can be used as seed in the following season (i.e. inbred varieties vs. hybrids), seed price (ranging from Rs. 15-300 per kilogram, or approximately US$ 0.20–4.90)[3] and seed rate (seed rate for hybrid cultivars is typically 10 to 15 kilogram per hectare, while that for inbred cultivars is 30 to 40 kilogram per hectare).

The hypothetical cultivars had one of three 'patterns' of yield: (1) higher yields than the 'check' variety (e.g., a comparison variety in agronomic trials commonly cultivated in much of eastern India) under all conditions (similar to the International Rice Research Institute's recently developed variety Sahbhagi dhan); (2) the same yield as the 'check' variety under normal conditions but higher yields under both moderate and severe drought stress; and (3) the same yield as the 'check' variety under both normal and moderate stress conditions but higher yield under severe drought stress. This approach explicitly acknowledges that seeds represent a bundle of potential yields – not just an average yield – including a range of yields under suboptimal conditions. Although many seed companies and research institutions focus on yields under normal conditions, risk-averse farmers care about yield variability and exposure to extreme weather events rather than just yield under 'normal' conditions.

Researchers also conducted experiments designed to determine farmers' attitudes towards risk and potential losses and collected data on household characteristics, agricultural production and experiences with both positive and negative economic shocks (including droughts).

Results

Farmers' levels of aversion to risk in particular strongly influence whether or not they are likely to adopt the hypothetical DT cultivars. This may be because farmers who are less averse to risk have already adopted improved cultivars and hence the DT cultivars do not offer as much advantage over their current cultivar. Alternatively, it may reflect the fact that risk-averse farmers are particularly sensitive to the risk of drought and hence value more highly the 'protection' offered by the DT cultivars.

Although the results indicate that farmers are willing to pay more for rice seed that yields more under all conditions than cultivars that are currently widely grown, they are also willing to pay significant amounts for seeds that outperform these 'check' varieties under drought stress even if they yield the same under normal conditions. Farmers also value the reduced risk of yield losses

resulting from severe droughts that DT cultivars provide, even when this reduced risk is not accompanied by higher average yields or even less variable yields.

Risk aversion and loss aversion also influence how much farmers are willing to pay for DT cultivars, but not how much they would pay for earlier maturity, lower seed rate or ability to save seed.

Taking into account farmers' risk and loss aversion, estimates indicate that farmers would on average be willing to pay Rs. 200 per kilogram (US$ 3.30) for seed of an inbred DT cultivar that out-yields the 'check' cultivar under all conditions (51, 32 and 16 maunds[4] per acre under normal, moderate stress, and severe stress conditions, compared to 50, 26 and 9 maunds per acre under normal, moderate stress and severe stress conditions. By comparison, they would be willing to pay Rs. 255 per kilogram (US$ 4.20) for seed of a hybrid DT cultivar that out-yields the 'check' under all conditions but by a larger margin (59, 36 and 17 maunds per acre under normal, moderate drought stress, and severe drought stress conditions). These figures are high, considering farmers in the sample paid an average of approximately Rs. 43 per kilogram (US$ 0.70) for seed in the previous monsoon season, but highlight how much farmers value DT.

The results indicate wide variation in farmers' attitudes towards different seed attributes, especially the need to buy new seed each year – a characteristic of hybrid cultivars – and for hybrids that out-yield the local check under all conditions.

Even though farmers on the whole preferred to be able to reuse grain as seed, the yield advantages of the DT hybrids was sufficient to offset this for many farmers, with the result that they would be willing to pay a premium for hybrid seed.

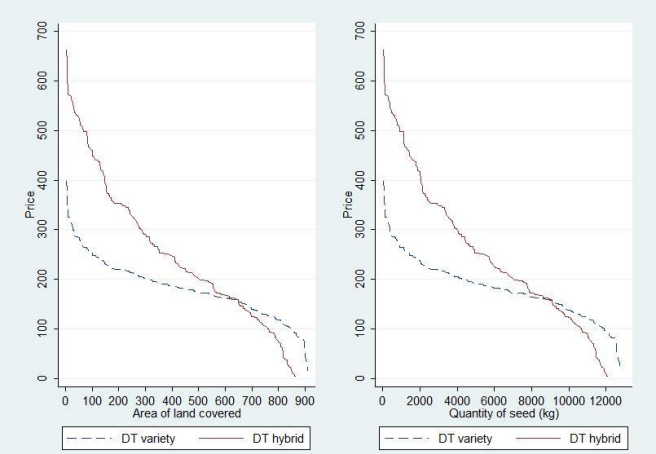

Figure 1: Demand curves for a hypothetical drought-tolerant hybrid and a drought-tolerant variety similar to Sahbhagi dhan

Bundling the effects of the various characteristics on how much farmers are willing to pay for a cultivar with a given set of characteristics showed very different patterns of demand for inbred and hybrid DT cultivars (Figure 1). The amount that farmers were willing to pay for hybrid DT cultivars varied widely, from nearly Rs. 700 per kilogram (US$ 11.50) to nothing, whereas the range for inbred DT cultivars was much narrower. However, on average, farmers were willing to pay more for DT hybrids than for inbred DT cultivars, which is unsurprising given the yield superiority of the hybrids for all yield 'patterns.' This suggests that, rather than competing, hybrids and inbred cultivars could serve different market segments. The results of the class modeling suggest that roughly 72 percent of farmers in the sample would prefer inbred DT varieties while 28 percent would opt for DT hybrids. Thus, there is a significant market for hybrids that the private sector could supply.

Policy and Research Implications

This research provides a novel analysis of demand for new, pro-poor technologies. Crucially, it demonstrates that analyzing the heterogeneity in farmer characteristics and resultant behavior identifies natural market segments that can be used to target research, development and marketing efforts. This presents opportunities for using a variety of channels and sectors to make the benefits of new technologies more widely accessible to poor and vulnerable farmers who would benefit the most from them.

In the case of DT rice, the research identifies two groups of farmers with different characteristics, one that has a clear preference for inbred DT varieties (of which they can save and replant seed), and one that has a preference for the performance characteristics of DT hybrids and is willing to pay for new seed each year. The two groups, which differ in terms of their attitudes to risk and losses, among other things, also have different preferences in terms of the type of drought response the rice cultivars express. These differences may be useful in guiding breeding efforts aimed at the different market segments.

The hybrid sector, which this research estimates at about 28 percent of farmers, is likely to be of primary interest to the private sector, given its need for repeat sales and the effective intellectual property rights that hybrids confer. However, there will be a continuing need for public-sector breeding of traditional, inbred varieties for the 72 percent of farmers who favor seed saving. This sector will be of little interest to the private sector, because of the limited possibility for return on investment in breeding efforts and seed production.

Although this study focuses on DT rice in the Indian state of Bihar, this research provides a methodological toolkit that researchers could use, for example, to explore demand for tolerance traits addressing other abiotic stresses such as submergence, salinity, excessive heat and excessive cold in rice, other staples such as maize or wheat, or non-staple crops such as vegetables or other horticultural crops.

[1]Ward, P.S., D L. Ortega, D.J. Spielman, and V. Singh (2014), "Heterogeneous Preferences for Drought Tolerant Rice: Evidence from Bihar, India." World Development 64: 125–139.
[2]See Ward et al. 2014 for details of the methodology used.
[3]US$ 1 = Rs. 60.81.
[4]A maund is a unit of mass commonly used in Bihar, equivalent to 40 kilograms.

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