CSISA Research Note 4

Public Subsidies, Technology Targeting and Private Investment: Evidence from Laser Land Leveling in Uttar Pradesh, 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

In many developing countries, governments use broad, unspecific subsidy programs to encourage the uptake of new agricultural technologies by small-scale and resource-poor farmers. But without careful targeting and keen analysis of their cost-effectiveness, these subsidies are often inefficient uses of scarce public resources and can also crowd out private sector provision of such technologies.

Formulating effective public programs to support the introduction and uptake of new technologies depends on understanding how poor farmers value these new technologies, what factors affect this valuation and whether the private sector can play a role in their provision. But farmers are a diverse group, and many different factors influence the value they place on new technologies. Finding out just what these influences are, and how they affect farmers' decisions about whether or not to invest in the technology, is complex.

A recent study[1] explores these issues by characterizing farmers' demand for a new agricultural technology – laser land leveling – in eastern Uttar Pradesh, India, and analyzing alternative strategies to inform public subsidies, technology targeting and private investment strategies.

Study Context and Design

Farmers in the rice-wheat system of eastern Uttar Pradesh typically rely on rainfall or groundwater to flood-irrigate their fields several times each season. But an uneven field – an undulating, sloping or rutted field – makes for inefficient use of water and requires costly diesel to pump water to the surface. To minimize this inefficiency, farmers traditionally level their plots using rudimentary tools, such as a wooden beam dragged behind a tractor.

Laser land leveling (LLL) uses a laser-guided drag scraper to achieve a similar result, but with much greater accuracy. LLL can reduce the amount of water used for irrigation and improve crop establishment and growth, thereby improving fertilizer efficiency, reducing weed pressure and increasing yields[2]. These benefits may endure for several years before re-leveling is required, depending on the soil type and on cultivation and harvesting practices.

LLL may also generate important public benefits in the form of reduced depletion of groundwater, runoff of chemical inputs, consumption of diesel fuel and the corresponding release of greenhouse gases. These benefits, combined with benefits to individual farmers, mean that LLL could broadly contribute to improving social welfare.

This study set out to understand how demand for LLL varies spatially and across different types of farmers in eastern Uttar Pradesh, and how this information can be used to design subsidy strategies that encourage LLL uptake, coverage and private provision of custom-hired LLL services. The study site included three districts in eastern Uttar Pradesh where rice-wheat systems dominate the landscape – Maharajganj, Gorakhpur and Deoria.

In total, 478 farmers in 24 villages were selected for the research project for the whole of the 14-month period during which data was collected (April 2011 to June 2012). In April and May 2011, the project convened an information session with sample farmers in each village to explain how LLL works, what its benefits and drawbacks are and how much custom-hired LLL services cost in other parts of India. Several days after these information sessions, the project held a non-competitive auction in each village to determine how much participating farmers were willing to pay for LLL. Farmers selected up to three plots they were interested in leveling, and then privately indicated whether they were willing to pay for leveling services at 10 different prices ranging from Rs. 250 (US$ 4.10)[3] to Rs. 800 (US$ 13.20) per hour. A threshold price was then drawn from an envelope; those who bid at or above that price won the auction. Using a simple lottery, the project then randomly allocated LLL services on a pay-for-service basis to half of the auction-winning farmers.

Several weeks after the information session and auction, a private service provider contracted by the project arrived to level the selected farmers' plots. Project staff accompanied the LLL teams to monitor their performance, collect data on the time required to level each plot and the costs incurred by the service provider, and record the payments made by farmers to the provider.

At the end of a complete agricultural year — one wheat crop and one rice crop — the project conducted a second auction for LLL services with the same farmers. The project again allocated LLL services on a pay-for-service basis, but this time without a lottery, so that all farmers who bid above a threshold price received LLL services.

Alongside this elaborate experimental design – information sessions, auctions, lotteries, leveling and monitoring – the project conducted detailed household surveys with participating farmers to collect information about their household demographics, assets and wealth, farm production practices, water use and other vital details. When combined, this information allows for the analysis of demand

for the technology and heterogeneity in demand and benefits. It also allows for exploration of how public subsidies and market-based provision of LLL interact to encourage LLL uptake and coverage.

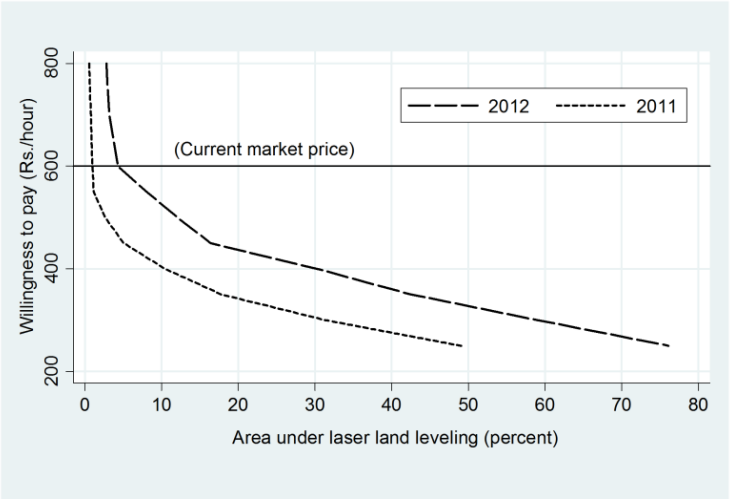

Figure 1: Demand for laser land leveling services increased at all price points once farmers had seen the technology in action

Results

Overall, the study estimated that LLL reduced water use by 25 percent for farmers who received the service following the 2011 auctions – a finding that is consistent with agronomic experiments undertaken in the region. This reduction in water use amounts to average savings of nearly Rs. 400 (US$ 6.58) per acre. As a likely result of the gains being observed by many farmers participating in this study, demand for LLL services in the subsequent 2012 auctions increased significantly at all price points (Figure 1).

Of course, not all farmers were willing to pay the same amount for LLL services. A number of household- and plot-level characteristics were associated with a farmer's willingness to pay for LLL or the precise amount he or she was willing to pay. Household-level characteristics influencing these factors included overall wealth, access to credit and willingness to take risk, while plot-level characteristics included plot size, ownership, how uneven the plot is and soil type. Demand for LLL services also differed significantly between districts, with demand in Deoria district being higher than in the other two districts, possibly attributable to slightly different soil and ecological conditions and smaller plot sizes found in the district.

A closer look at the data on farmer heterogeneity suggested that subsidies designed to reduce the price farmers pay for LLL services could dramatically increase LLL adoption. The study estimated that less than 10 percent of the land in any district would be leveled using LLL at a full market price of Rs. 600 (US$ 9.87) per hour (as found in other parts of India), while at half that price more than 50 percent of the land would be leveled.

This opened the door for a series of simulations to better understand how public subsidies could be better targeted to encourage private provision of LLL services to a greater number of farmers or on a greater area of land. A starting place for these simulations was to consider the subsidies for LLL that many Indian states have recently introduced or are considering: a discount on the purchase price of an LLL unit that would translate roughly to an effective subsidy of Rs. 45-80 (US$ 0.70-1.30) per hour in eastern Uttar Pradesh. Using this figure as the benchmark for near-term public support for LLL, the project tested targeted strategies to promote uptake of LLL that are comparable in total public cost to this subsidy level.

The project then considered two objectives for these strategies: (1) reducing the amount of groundwater used for irrigation; and (2) improving the profitability and welfare of small-scale and resource-poor farmers. If policymakers are primarily concerned about excessive extraction of groundwater, then the primary objective of their targeting strategy should be to increase the area of land farmers level using LLL. On the other hand, if policymakers are primarily concerned about farmer welfare, the primary objective should be to increase the number of farmers using LLL.

The project developed and simulated the impact of a range of cost-comparable targeting strategies, including:

- **The status quo:** This is based on the LLL business model from the western Indo-Gangetic Plain with the current market price of Rs. 600 (US$ 9.87) per hour of leveling time.
- **A simple uniform subsidy of Rs. 80 (US$ 1.30) per hour:** This is the high-end estimate of the effective hourly subsidy of current LLL equipment subsidies. This provides a benchmark with which other targeted subsidies can be compared.
- **Perfectly targeted subsidies:** In this case, a farmer receives a subsidy equal to the difference between what he or she is willing to pay for LLL and the market price. This is unrealistic, but provides a standard against which to compare more feasible but otherwise imperfect strategies.
- **Targeting by district:** Service providers charge different prices in different districts depending on demand for LLL. Based on the differences in demand observed between districts, this strategy offers a Rs. 130 (US$ 2.14) per hour subsidy to two districts and no subsidy to the third.
- **Targeting by landholding:** Although landholding did not appear to influence demand for LLL, this may be attractive to policymakers wanting to ensure benefits to poorer segments of the community.
- **Targeting by poverty status:** This is often a popular segmentation approach in India, for instance providing discounts to households that hold a Below Poverty Line (BPL) card.
- **Implicit targeting by first-hour discount:** A first-hour discount has the practical advantage of being potentially familiar to private sector service providers as a marketing tactic, and generally favorable to farmers with smaller landholdings. A first-hour discount of Rs. 182 (US$ 2.99) exhausts the subsidy budget and generates an effective average leveling rate that ranges from Rs. 418-585 (US$ 6.90-9.60) per hour.

These targeting strategies were assessed for their impact on: (1) total acreage under LLL; (2) total number of farmers adopting LLL; (3) total water savings attributable to LLL; (4) cost-effectiveness of bringing additional acres and farmers into LLL (subsidy cost per additional acre or farmer); and (5) a measure of economic welfare outcomes.

When compared to the status quo strategy, the perfect targeting and first-hour discount strategies produced the largest increases in the percentage of farmers using LLL, the number of acres under LLL and total estimated water savings due to LLL. From a welfare perspective, the first-hour-discount strategy also comes out ahead, generating greater consumer surplus than the current market

strategy – i.e. the farmers are able to buy LLL services for less than the highest price they would be willing to pay.

When the service provider's costs were taken into account (Figure 2), the first-hour discount was also found to be the most cost-effective way to increase the number of acres leveled, while perfect targeting was the most cost-effective means of increasing the number of farmers leveling their land. By contrast, targeting by district and by landholding was not cost-effective because they both resulted in net losses for the service provider.

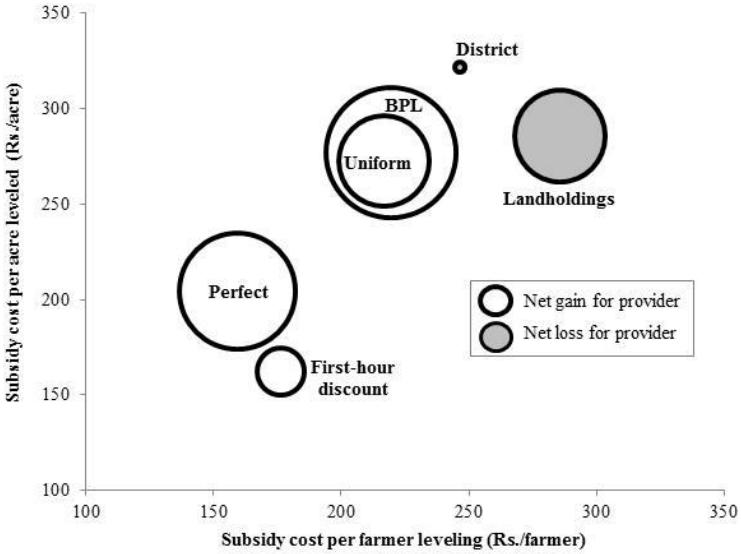

Figure 2: Perfect targeting and first-hour discounts were the most cost-effective strategies that were also profitable for service providers. *Note: BPL = below-poverty-line status (whether household head has an official BPL card). Bubble size indicates profit for private laser land leveling service provider adjusted for Rs. 18,000 (US$ 296) subsidy.*

Conclusions

For many agricultural technologies, governments have the opportunity to make use of public subsidies strategically – to popularize their use among farmers, to encourage private sector participation and to improve both individual welfare and the common good. While governments may often prefer broad, unspecific subsidies to promote the rapid dissemination of these technologies, there are often better ways to use scarce public funds. This study demonstrates how better information on farmers' willingness to pay for a technology and the private sector's costs of technology provision can be used to design more effective uses of public subsidies.

In the context of LLL in eastern Uttar Pradesh, the study suggested that first-hour discounts – relative to other strategies – would increase the number of acres leveled and the number of farmers leveling their land, ensure the profitability for service providers and make good use of public subsidies. This is in stark contrast to the status-quo strategy of subsidizing the purchase price of LLL equipment that is being used or considered by many state governments in India currently.

Although these conclusions are not immediately applicable to other similar technologies or states, they demonstrate the value of good information in designing and evaluating of alternative marketing and subsidy strategies. The methodology and analysis in this paper provide insight into the targeting considerations and tradeoffs associated with promoting a new technology among small-scale, resource-poor farmers through public subsidies, private discounts or some combination of the two.

[1]Lybbert, T.J., N. Magnan, D.J. Spielman, A. Bhargava, and K. Gulati (2013), "Targeting Technology to Reduce Poverty and Conserve Resources: Experimental Delivery of Laser Land Leveling to Farmers in Uttar Pradesh, India." IFPRI Discussion Paper no. 1274 (Washington, DC: IFPRI); Lybbert, T.J., N. Magnan, A.K. Bhargava, K. Gulati, and D.J. Spielman. 2013. "Farmers' Heterogeneous Valuation of Laser Land Leveling in Eastern Uttar Pradesh: An Experimental Auction to Inform Segmentation and Subsidy Strategies." American Journal of Agricultural Economics 95(2): 339–345.

[2]Jat, M.L., P. Chandna, R. Gupta, S. Sharma, and M. Gill (2006), "Laser Land Leveling: A Precursor Technology for Resource Conservation." Rice-Wheat Consortium Technical Bulletin Series 7 (New Delhi: Rice-Wheat Consortium for the Indo-Gangetic Plains); Jat, M.L., M.K. Gathala, J.K. Ladha, Y.S. Saharawat, A.S. Jat, V. Kumar, S.K. Sharma, V. Kumar, and R. Gupta (2009), "Evaluation of Precision Land Leveling and Double Zero-Till Systems in the Rice-Wheat Rotation: Water Use, Productivity, Profitability and Soil Physical Properties." Soil and Tillage Research 105: 112–121.

[3] US$ 1 = Rs. 60.81

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