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Research Prizes: A Mechanism to Reward Agricultural Innovation in Low-Income Regions

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This paper identifies market failures that limit biotechnology research for farmers in low-income regions and proposes a system of cash prizes to reward the dissemination of successful innovations. The prize authority would specify a target region (e.g., Sub-Saharan Africa) and offer to pay a fixed proportion (e.g., 20%) of the estimated social value of any innovation, computed using standard procedures, to buy out the innovation into the public domain. A governance structure to ensure credibility and financial sustainability is proposed.

Key words: intellectual property, biotechnology, incentives for research, private provision of public goods.

Motivation

Agricultural research can be a key driver of economic growth and sustainable poverty alleviation, offering average economic returns well above the cost of capital (Alston, Marra, Pardey, & Wyatt, 2000). Biotechnology has particular promise in low-income regions, where persistent market failures continue to limit the incentives and resources available to researchers despite widespread experimentation with new institutional arrangements (e.g., Byerlee & Echeverria, 2002).

To help biotechnology fulfill its potential, researchers will need stronger enforcement and easier marketability of their intellectual property rights (e.g., Graff & Zilberman, 2001) as well as a range of enabling public-sector institutions supported from philanthropic and public-sector sources (e.g., Conway & Toenniessen, 1999). This paper proposes a way to complement intellectual property rights (IPRs) and public investment with a third kind of mechanism, designed particularly to promote innovation in the lowest-income regions such as Sub-Saharan Africa.

The proposal is designed to help donor institutions elicit public-good applications of research that is (or could be) IPR-protected, by awarding cash prizes for the dissemination of valuable innovations. Wright (1983) analyzed the incentive effects of funding research with prizes as opposed to contracts or intellectual property rights, and Kremer (2001) has recently proposed a particular type of prize as a way to stimulate pharmaceutical research on malaria, tuberculosis, and other diseases. Kremer and Zwane (2002) suggest that their same mechanism could work for tropical agriculture as well.

In this paper, we adapt the research prize concept to the technological needs of agriculture, using several differences from previous approaches to make the prize incentives compatible with existing institutions. In particular, whereas most prize schemes specify a technological hurdle, here the prize authority would offer to pay a fixed percentage of the economic value of *any* innovation, specifying only the kinds of trials and surveys by which that value could be measured—much as the United States Food and Drug Administration (FDA) specifies the procedures by which medical innovations are judged safe and effective, but in this case computing economic value instead. In addition, whereas most prizes allow the innovation to remain IPR-protected, here the prize would place the innovation into the public domain—much like the patent buy-out proposals of Kremer (1998), but in this case allowing innovators to choose between IPR protection and a sale to the public sector.

The proposal is motivated by the persistence of market failure in research, despite IPRs and public funding. The nonrival quality of research results can be remedied by enforcing IPRs, but this works only by granting monopoly power over innovations, which in turn limits the extent to which the innovation is actually used (Scotchmer, 1991). Many benefits of research are in fact nonexcludable as well as nonrival, particularly for agriculture in low-income regions, where producers have little savings or collateral with which to pay license fees even for technologies they know are profitable, and where much of the benefit of new technology is passed on to consumers in the form of lower prices.

The provision of nonexcludable benefits requires public funding, but because taxpayers and public officials cannot easily observe the quality or quantity of research, it is difficult for them to contract for it. This proposal provides a way for philanthropic and government funding sources to pay directly for demonstrated research achievement, providing incentives and resources for successful innovation in a way that com-

plements a wide variety of IP regimes and research institutions.

Implementation and Incentive Effects of the Proposed Prize Mechanism

Our proposal's most important difference from past prizes is that it would prespecify only the target region and the formula by which prize amounts could be computed, without prespecifying which technologies would be eligible. The awards would be a fixed percentage of the economic welfare gains from the innovation, computed using standard techniques as in Alston, Norton, and Pardey (1995). In this respect, our proposed system would be somewhat like the drug approval process in the United States, where the FDA specifies how applicants can use clinical trials to document the safety and efficacy of their innovation. In the agricultural context, applicants would document the economic value of their innovation using field experiments, farm surveys, and market prices.

The documentation needed to claim a prize would consist of: (a) *experimental data* from on-farm or market trials, to establish the physical productivity differences between the innovation and prior art; (b) *economic data* from market surveys or secondary data, to establish the relative prices of the inputs and outputs whose quantities are affected by the innovation; (c) *adoption data* from sample surveys, aerial photography, or other sources, to establish the extent to which the innovation is used in a given market; and (d) *model structure and parameters,* inferring what is locally unobservable from economics research conducted elsewhere.

A starting point for the model and its parameters might be a partial-equilibrium model with parallel shifts of a linear supply curve and supply and demand elasticities taken from a prespecified set of estimates. The prize authority would specify procedures for collecting and documenting each kind of data and the formulas by which the data could be used to compute annual gross benefits and their net present value. Such a sequence of calculations is relatively transparent and is no more complex than a company balance sheet. (Training materials and numerous case studies applying this approach in African research institutions are available at http://www.agecon.purdue.edu/staff/masters.) In any case, the incentive effect of the prize system is unlikely to be more affected by the use of one model and set of parameters than another. The key factor is that awards would be proportional to the basic data described in (a), (b), and (c) above, thereby helping to align researcher institutes' objectives with the interests of farmers and other potential beneficiaries.

A second key aspect of the award is its timing. Applicants could submit their innovation to claim a prize as soon as their data were collected and analyzed, typically after two or three years of adoption; to encourage early application, an additional two or three years of projected adoption could be allowed in computing estimated social value. Even so, because the required research must have been initiated many years before the prize can be claimed, at the start of the prize program its principal function would be to reward *past* successes, to channel additional income to those institutions capable of generating needed innovations and documenting their value. Only after some years would the prizes have a significant incentive effect on research: first to induce institutions to do the kinds of trials and surveys needed to document social value, then to ensure that promising technologies are actually disseminated, and finally to allocate research and development (R&D) resources to make more promising technologies. In each of these roles, the prizes would be a marginal source of funding, aimed at complementing rather than replacing other institutional arrangements.

The proportion of social gains to be offered in the prize might be on the order of 10-20%, an amount big enough to stimulate research, but less than the share of social gains that might be captured from heavily-enforced patent rights—such as the 37-44% of the benefits from Roundup Ready soybeans estimated to have been captured by its developers (Moschini, Lapan, & Sobolevsky, 2000). To ensure incentive compatibility, these prizes would be one-time payments that would buy the innovation into the public domain. Because the innovator is free to ignore the prize where IPR protection might offer greater reward, the prize mechanism complements the market without undermining market development.

The prize proposal's compatibility with IPR protection is particularly important for biotechnology, as the prizes would create additional incentives for applications where benefits are nonexcludable, without disrupting the development of IPR-protected applications to technologies for which relatively high license fees are feasible. For example, prizes could support the public-sector development of Bt maize, even as Bt cotton is sold under license. The prize mechanism would also greatly facilitate private-public partnerships, as IPR holders could license their technologies to public insti-

tutions on a contingency basis in exchange for a share of any prize.

Finally, our proposed mechanism would be funded on a pay-as-you-go basis and governed jointly by donors and potential claimants, in order to limit the time-consistency and credibility problems often associated with prize schemes. We propose that the prize-giving institution be governed by a board of twelve members, of which four would be elected by donors who vote in proportion to their financial support, four would be elected by research institutions in proportion to the number of scientists working in the target region (e.g., Africa), and four independent members acceptable to both groups. Each might serve a staggered four-year term, so that one from each group is replaced every year; a ban on receiving prizes while sitting on the board would help ensure that the institution's policies are fair and transparent.

The size of the prize fund would be expected to vary over time. On the endowment side, donors could start small and add funds over time, if they found that the mechanism was successful in identifying and supporting the most successful research ventures. On the award-disbursement side, payouts would vary over time as the applications came in. Most likely, there would be few applications at first, because it would take time for researchers to assemble the data needed to apply, so fund balance would rise and then might remain roughly constant if inflows matched outflows.

If the prize mechanism proved unattractive to donors, then inflows would slow and payouts would gradually erode the balance until the experiment ended. If the prize mechanism proved unattractive to researchers, then the board could adjust the award formulas to increase the payout. In sum, the award authority would be a kind of marketplace through which to balance the demand and supply for research: If the approach proved attractive to both researchers and donors, then annual inflows and outflows would both grow.

Researchers' expectations about the fund's future solvency or payout procedures, and donors' expectations about the kinds of research their money would reward, would depend entirely on the fund's performance from year to year. Unlike the Kremer (2001) vaccine-purchase fund, it would not be necessary or even desirable for the fund to accumulate a large cash balance at the outset, because the flow of agricultural research to be rewarded is not an all-or-nothing proposition. In agriculture, unlike vaccine research, progress typically involves a large number of incremental improvements in specific crops and adoption domains, each of which can be rewarded separately as they are documented in applications for research awards.

Conclusions

The prize mechanism proposed here is tailored to the particular challenges and opportunities of research in agriculture as opposed to other sectors, in order to help align incentives facing researchers and funding agencies with the needs of technology users. Offering prizes would complement rather than substitute for other forms of research funding. Establishments that are now funded through research contracts or patent revenues would see the prizes as a potential additional source of revenue, providing a marginal incentive to produce valuable but nonmarketable technologies for which they currently obtain little reward, and channeling resources to talented or well-placed researchers whose successes are well-documented.

Agricultural R&D has been a critical driver of economic growth and poverty alleviation around the world. However, for the lowest income farmers, particularly in Africa, research expenditures have been relatively low and slow growing. The magnitude and significance of a prizes program is difficult to predict, but if focused entirely on Sub-Saharan Africa, it might be used to channel something on the order of $10-100 million per year, or 1-10% of all agricultural R&D in Africa. By complementing other kinds of research funding, such prizes could substantially improve the targeting and increase the amount of all research activity aimed at low-income regions.

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Author's Note

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