Ag Aid and Tech Breakthroughs

Pull Funding for Smallholder Productivity

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Abstract

With the growth in annual yields for key staple crops falling and global population projected to add another two to three billion mouths to feed by 2050, farming practices, service delivery, and marketing will all need to be improved to meet increased demand sustainably. It's a tall order, and donors and aid recipients alike are frequently frustrated by the underwhelming results and high transactions costs of much foreign assistance today. "Pull mechanisms" are not a silver bullet, but some donors see them as a tool to address this particular intersection of problems—stimulating innovation, pulling in the private sector, and making aid delivery more effective by paying for outcomes rather than inputs.

An earlier paper (Elliott 2010) reviewed the market failures that inhibit socially optimal levels of research and development—in developing countries in general and in developing-country agriculture specifically—and the factors involved in choosing between push and pull mechanisms. The focus here is on factors to be considered when choosing among pull mechanisms and on what the limited experience with pull mechanisms can tell us about the potential utility of these instruments. The experience so far suggests that donors remain more comfortable with traditional ways of funding research and development from the top down and are still cautious about using new mechanisms that provide more space for innovation from the bottom up.

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Contents

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Introduction

People today are hungry or malnourished because they are poor, or because ample global food supplies are not where they are most needed. Going forward, however, the basic task of producing enough food globally will face escalating challenges as a result of changes in both demand and supply. On the demand side, the global population is expected to grow by a third or more, rising incomes will increase demand for more resource-intensive food products, and biofuel policies are diverting growing amounts of food crops to energy uses. On the supply side, competition with urban areas for arable land and water resources will intensify, yield growth is slowing, and climate change is expected to increase the number of extreme weather events.

A range of policy tools will be needed to address these food security challenges. Reform of distorting trade policies would increase incentives to invest in developing country agriculture and help food get to where it is needed more efficiently. Reductions in biofuel subsidies that pit food against fuel, or unsustainably increase land use, could reduce pressure on food supplies, and better serve climate change mitigation goals.

Policy reforms can only go so far, however, and innovation to reverse declining productivity growth is essential. From 1960 to 2000, the average annual growth in yields for key staple grains fell by half (Fischer, Byerlee, and Edmeades, 2009, p. 10). The public sector played an important role in the first green revolution and will no doubt do so in the next one, but there is increasing awareness that the enormity of the task requires leveraging the resources of the private sector as well. Moreover, donors and aid recipients alike are often frustrated by the underwhelming results and high transactions costs of much foreign assistance today. And all parties share a desire to avoid having new technologies end up on the metaphorical shelf collecting dust because neither the hard nor soft infrastructure needed for well-functioning markets is in place to make them profitable. All of these factors point to the need for more innovative financing mechanisms to address the challenges of food security.

Elliott (2010) analyzed the range of market failures that inhibit innovation generally and in agriculture in particular. As summarized in box 1, the fruits of innovation are often harder to capture in agriculture than in other areas, such as pharmaceuticals, and the private sector role in agricultural R&D is lower overall. It is also concentrated in areas that are less relevant or harder to adapt for the problems facing smallholders in developing countries, such as machinery or chemicals. Beyond that, there are other market failures in developing countries, and especially in sub-Saharan Africa, that discourage farmers from adopting new technologies because they are not profitable under existing market conditions. Too often, key infrastructure is weak or missing and agricultural supply chains are undeveloped.

No single policy tool can address all these market failures, but "pull mechanisms" are designed to address a range of problems around stimulating innovation, pulling in the private sector, and making aid delivery more effective. Pull mechanisms are results-based tools that

reward innovations when delivered and they are generally preferable to traditional "push" mechanisms, such as up-front R&D grants, when there are many potential problem solvers and the donor is unsure on the best path to solving the problem.

Box 1: Market Failures in Innovation, Agriculture, and Developing Countries

Innovation is a classic public good and market forces alone typically fail to induce socially optimal levels of research and development. A common solution to the market failure is to grant innovating firms patents that give them a period of market exclusivity during which they can sell products at prices above competitive levels to recoup their costs. But other market failures can undermine the effectiveness of patents. For example, where R&D costs are high and market demand for new technologies is uncertain, patents may be insufficient to attract private investment. This is often the case with basic scientific research, where the information generated is crucial for subsequent innovation, but commercial applications are not immediately obvious.

Patents also provide insufficient incentives for innovation if the characteristics of the technology are such that it is difficult for inventors to profit from their efforts. For example, farmers can use seeds from crops that are self-pollinating year after year, making it difficult for inventors to enforce patents. In the United States in 2000, for example, the private sector accounted for 72 percent of all R&D spending, but only 55 percent in the agriculture sector. And within agriculture, private sector R&D tends to focus on areas where the benefits are more easily appropriable, such as hybrid seeds that have to be replaced every year or two, chemical inputs, and machinery (Pardey and Alston 2010, pp. 6, 9).

If patents and other protections for intellectual property traditionally used in rich countries are less powerful for agriculture than for other sectors, they are even less helpful in stimulating innovation specifically for developing country problems. Excluding China and India, low-income countries collectively constitute a market that is too small and poor to make large R&D investments profitable. In African agriculture, the obstacles are even larger because there are many staple crops that are not demanded in significant quantities elsewhere. Given these challenges, it is no surprise that the share of private investment in total agricultural R&D spending in developing countries was only 2 percent in 2000 and just 5 percent of private R&D spending was in developing countries.

In areas of research where intellectual property rights are not sufficient to allow innovators to capture the fruits of their labor, governments often rely on direct funding of R&D to subsidize the development of technologies they expect to have large social returns. While this traditional approach is and will remain an important part of the R&D landscape, it raises other dilemmas related to what economists call principal-agent

problems. Kremer and Zwane (2004, pp. 92-93), for example, note that asymmetric information is a problem between donors and researchers and that the incentives of donors and researchers may not be aligned. Making research grants ex ante, when donors have incomplete information, can lead to wasted resources if donors pick the wrong winner among various proposed approaches to a problem. Kremer and Zwane also point to the risk that R&D allocations can become politicized, again wasting resources. These are among the market failures that pull mechanisms are designed to address.

Adapted from Elliott (2010).

This paper begins by placing pull mechanisms in the broader context of incentive-based mechanisms for more effective aid delivery. It then explores in more detail than the earlier paper just when pull mechanisms might be appropriate, as well as the conditions favoring one pull mechanism over another. Experience with pull mechanisms for development is relatively limited, but two recent experiments are discussed in the latter part of the paper: the "advance market commitment" (AMC) for pneumococcal vaccines for developing countries; and the Agricultural Pull Mechanism Initiative, which was created after the G20 summit leaders in Toronto in 2010 called for exploration into using AMCs or other innovative financing mechanisms for developing country agriculture.[1] The steering committee for the latter initiative plans to launch one or more pilots around the time of the G20 summit in Los Cabos, Mexico in June 2012.

Incentives and Effective Aid Delivery

Even before the recent budget pressures became severe, donors were looking to make aid more effective and less costly.[2] Incentive-based approaches to aid delivery, including pull mechanisms such as AMCs or prizes, are one of the mechanisms that donors and recipient governments are increasingly using, "not only to improve efficiency and sustainability [of aid] but also to encourage innovation and promote behavioral changes" (Savedoff 2011, p. 1).

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[1] The World Bank's office for Concessional Finance and Global Partnerships hosts the website with information on the Agricultural Pull Mechanism Initiative at http://web.worldbank.org/WBSITE/EXTERNAL/EXTABOUTUS/ORGANIZATION/CFPEXT/0,,contentMDK:23005969~pagePK:64060249~piPK:64060294~theSitePK:299948,00.html, accessed March 13, 2012.

[2] The principles for more effective aid, as well as a monitoring process for tracking progress, are set out in the Paris Declaration and Accra Agenda for Action: http://www.oecd.org/document/18/0%2C2340%2Cen_2649_3236398_35401554_1_1_1_1%2C00.html, accessed May 22, 2012.

What distinguishes incentive programs from other modes of aid delivery is that they pay ex post, for outputs or outcomes, rather than ex ante, for inputs, and they can produce better results when the donor is uncertain as to the best technology to solve a problem or the most effective process for delivery of a product or service. Among the other benefits, donors pay only for results and recipient countries may find that the burden they bear in terms of consulting with and reporting to donors is lighter under some incentive-based approaches.

Savedoff (2011) develops a framework for analyzing incentive programs that arrays them according to the type of agent they seek to engage, from individuals to countries, and in the nature of the objective sought (figure 1). In one corner of the framework, we see tools that target individuals in pursuit of a single, focused objective, such as incentives for individuals to complete tuberculosis treatment. In the opposite corner, we see funding mechanisms applied at the country level that may have multiple and broad objectives, such as general budget support for governments that meet minimum standards of good governance.

Within this framework, pull mechanisms have relatively focused objectives, in this case innovation and technology adoption, and they generally aim to engage non-governmental entities, which could be individuals, households, publicly-funded research institutes, or private sector firms. According to a narrow definition of a pull mechanism endorsed by some advocates of the idea, it should be a tool used as a temporary subsidy to overcome market failures inhibiting innovation and to create a self-sustaining private market. But that is too narrow if there are innovations where public goods are involved. In those cases, the definition of sustainability should accommodatethe possibility that the market alone will not promote socially beneficial levels of dissemination. Thus, in the vaccine AMC case, the donors' goal was to pull in private sector resources to create a sustainable supply of vaccines adapted and priced for developing country needs. Donors never intended to create a private market for the purchase and use of vaccines and paired the AMC initiative with existing programs that provide subsidies for the purchase of vaccines by governments in poorer countries.

Choosing Among Pull Mechanisms for Innovation

In short, pull mechanisms aim to stimulate innovation and leverage private sector capital, know-how, and other resources in the development of technologies for developing country problems that would otherwise attract little attention or investment. To briefly reiterate the distinguishing features of pull mechanisms from the discussion in Elliott (2010), donors pay only upon delivery of an innovation or product that meets certain conditions and, in some mechanism designs, they pay only when the product passes a market test and is adopted. Pull mechanisms are useful when donors cannot easily monitor research quality and incentives between the donor (principal) and researcher (agent) are not aligned. Using a pull mechanism also allows donors to avoid having to pick winners among competing technological approaches ex ante, when they do not have complete information. If so designed, pull

mechanisms can also help to overcome information asymmetries between researchers and consumers by linking payments to adoption.

Elliott (2010) reviews in some detail the advantages that advance market commitments (AMCs) have in mimicking market forces and leveraging private sector resources to address developing country problems. That paper also analyzes a proposal for proportional prizes that builds on the fact that innovations leading to improved agricultural productivity tend to be incremental (Masters and Delbecq 2008). In addition, there is growing interest in the use of more traditional innovation prizes for development problems and the Agricultural Pull Mechanism Initiative includes those, as well as patent buyouts, proportional prizes, and AMCs as potential models for pilot projects. This paper briefly discusses key features of these instruments and then develops a framework for choosing among them in particular situations.

The appropriate pull mechanism in a given situation will depend on a number of factors, but two stand out. The first is the degree of information the donor has about potential technological solutions to a problem and the degree to which the donor is able to specify desirable attributes of the technology. The second is a willingness by potential competitors to take on risk and their access to finance, initially for the R&D process and then for commercialization and dissemination. The interaction of these two factors and the resulting choices of pull mechanisms are summarized in table 1.

Prizes are a familiar pull mechanism that have been used for centuries to reward innovation when funders do not know the best technological path to a desired outcome. They are often "winner takes all" contests that pay a lump sum to the first competitor to achieve a stated objective. In recent years, the X Prize Foundation has attracted significant attention with high profile prizes for developing a 100 mpg car and promoting private sector capability for space travel. The use of prizes has grown sharply in recent decades, with the total value of prizes worth more than $100,000 estimated to have increased 15-fold since the 1970s (McKinsey and Company 2009, p. 16). The X Prize Foundation suggests that prizes work best toward problems that are attention-grabbing and can capture the imagination. Consistent with that, recent research finds that the prestige of winning is a greater incentive than the money and many studies find that competitors spend as much or more in developing a technology as they receive in prize money (Masters and Delbecq 2008, p. 3). One explanation for this is that the publicity and recognition increase the marketability of the resulting product.[3]

[3] McKinsey and Company 2009, p. 31, and Brunt et al. 2008.

Table 1 Using Pull Mechanisms for Innovation		
Is finance for R&D, other up-front costs available?	**Is the optimal technological path to a solution specified?**	
	Yes	***No***
Yes	AMC Patent buyout	Prize with guaranteed value (generally for breakthrough innovations) Prize amount divided among winning contestants proportional to social benefit (for incremental innovations)
No	Milestone prize	Grant

Applications of prizes to development problems are relatively new and untested. As of May 2012, the X Prize Foundation listed two prizes under development in its education and global development portfolio with only one them specifically aimed at a developing-country problem (diagnostics for tuberculosis). By comparison, in early 2012, there were two prizes awarded in the energy area, two awarded and one active prize in the exploration area, and two active prizes in life sciences.[4] As noted above, however, prizes seem to work best when competitors expect to be rewarded in the market and they may be less effective as traditionally designed when there are downstream market failures that undermine technology adoption, as in many developing countries.

A variant on the traditional winner takes all prize is a milestone prize that pays out at various stages, rather than only once at the end. This approach also differs from traditional prizes in another important way because, far from being technology-neutral, setting the criteria for prize payments at the various milestones requires some idea of the technology being sought and, perhaps, development of a detailed target product profile. BIO Ventures for Global Health (BVGH) opted for a milestone prize model because they specifically wanted to engage biotech companies that are often of small-to-medium size. To address the specific

[4] See http://www.xprize.org/prize-development, accessed March 13, 2012.

problems those companies face in financing research, particularly for developing country problems, BVGH developed a prize scheme for a "point of care fever diagnostic" to distinguish malaria from pneumonia and other diseases and facilitate appropriate treatment. If funded, payouts would be made at four stages—proof of concept, prototype build and evaluation, clinical validation, and regulatory approval. As many as 15 competitors could be eligible for small prizes in the first stage, with larger prizes available to mitigate risk and provide some next-stage finance for 2-3 firms reaching the later milestones.[5]

Another variant is a proportional prize model developed by Will Masters specifically for African agriculture, where progress is often incremental and successful technologies difficult to predict. Like traditional prizes, the proportional prize sets a goal—in this case, raising agricultural productivity—and it is completely neutral with respect to technologies for achieving that goal. Prizes are rewarded in proportion to their measured (and verified) social benefit, which, unlike most traditional prize designs, includes evidence of adoption (Masters and Delbecq 2008). But, while adoption is included, the prize design does not include incentives to scale up dissemination of the winning technologies. The assumption is that either the market will be sufficient to encourage broader adoption, or that the public sector will take on the task through separate policies.

A patent buyout resembles a prize in important ways, in that donors commit to pay an innovator for developing a technology that addresses a specified problem, but it differs in that buying out the patent ensures the knowledge is broadly disseminated. This mechanism is sometimes suggested as a solution to promote broader availability of patented products that are otherwise too expensive for most developing country consumers. But the promise of a patent buyout, if credible, could also encourage innovation that might not otherwise occur at all because developing country markets are too small and too poor to attract attention to their specific problems. Even then, delivery and adoption could be a problem if there are too few potential producers or other market failures that impede commercialization.

A very different model was spelled out in a CGD working group report that developed a detailed proposal for an advance market commitment (AMC).[6] The report created templates that could be used either for research, development, and delivery of vaccines at early stages, or to accelerate the scaling up of production and delivery of existing vaccines adapted for developing country markets (Levine, Kremer, and Albright 2005). The key elements of the AMC as originally designed were a commitment by donors to pay a subsidized price per dose for a designated number of doses, if the vaccine was demanded by developing country governments. In return for the subsidy, which was intended to cover up-front R&D and other investment costs, contracting firms agreed to continue supplying the drug for a

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[5] http://www.bvgh.org/What-We-Do/Incentives/IQ-Prize.aspx, accessed April 10, 2012; for a brief analysis of the proposal, see http://healthresearchpolicy.org/blog/2011/sep/9/BVGH-fever-diagnostic-prize.

[6] Both the AMC and the proportional prize, discussed above, are analyzed in more detail in Elliott (2010).

minimum number of years at an affordable price (near marginal costs). The application of this model to promote the roll-out of new pneumococcal vaccines in developing countries in the late 2000s is discussed below.

In sum, winner-take-all prizes are useful when funders are neutral regarding the preferred technological path to achieve a goal, and are most often used in situations where a breakthrough technology is sought. Proportional prizes can also be used when donors are uncertain on the most appropriate technology for a given problem, where progress is more likely to be incremental, and where a variety of different innovations could contribute to the desired end. Milestone prizes require more specificity regarding attributes of the desired technology and can be used when seeking to engage smaller firms or access to finance is a problem in the R&D phase. Advance market commitments are useful when donors have an idea of the type of technology they want, but do not have the information to specify the best path for developing it and do not want to pick a winner ex ante.

In developing country contexts, and in agricultural markets particularly, overcoming market failures that inhibit innovation is often only the beginning, however. AMCs are designed to create markets and to pay out only when products are adopted. And, if there are many potential producers and the potential market is well-developed enough to support commercialization and delivery of a technology, then a patent buyout will be efficient from a social perspective. The innovator is compensated for making the discovery but the product can be sold at close to marginal cost, making it more affordable and permitting it to be broadly disseminated. But if product markets are not well-functioning, prizes and patent buyouts, which often assume that markets can take care of dissemination, will need to find a way to address those other market failures in the mechanism design or identify complementary measures that can address them.

Pull Mechanisms for Innovation *and* Adoption

In moving from product innovation to commercialization and adoption, a number of additional market failures can arise, including:

- imperfect information, which in turn can interact with economies of scale and social externalities to prevent socially optimal technological uptake;
- behavioral tendencies among consumers that make it difficult to save and invest in new products or practices;
- broader market conditions that make investing in agricultural productivity unattractive.

Figure 2 summarizes the potential obstacles to sustainable technology adoption and indicates the most appropriate pull mechanisms in response. It also indicates other policies that

donors might want to consider as complements or alternatives to pull mechanisms as defined here.[7]

Technology adoption is frequently impeded by imperfect information—on the part of the producer with respect to market demand and whether it will be sufficient to cover start-up costs and allow exploitation of scale economies; and on the part of the consumer with respect to the benefits of new technologies. Prizes linked to adoption can be useful when donors want to overcome producer uncertainty about a market when risks are relatively low and a relatively small incentive is needed to stimulate roll-out of a technology. Since competition is an important element in a well-functioning market, donors should design the prize to be paid proportionally to adoption or effective use, rather than in winner takes all form. An example is the Haiti Mobile Money initiative, funded by the U.S. Agency for International Development and the Bill and Melinda Gates Foundation to encourage faster dissemination of mobile banking services, especially in rural areas, and to facilitate the transfer of remittances to survivors of the earthquake. The Haiti Mobile Money project offered lump sum payments to the first two companies to launch mobile money services and then an additional prize to be paid out proportionally based on the number of new subscribers using cell phones for e-banking.[8]

For products where producer uncertainty about demand combines with high capital costs and economies of scale matter, an AMC, or per-unit subsidy, may be more effective. By subsidizing those up-front costs, donors help create a market by allowing producers to sell at a price that is just above where marginal costs will be when scale economies are achieved. If there are no other market failures, and depending on the size of the donor commitment, negotiation of a long-term supply commitment may not be necessary. In some cases, where consumers are uncertain about the benefits of a technology, a pay for performance scheme for extension services, producers, or NGOs to illustrate benefits and provide training on effective use of a new technology may be a more effective approach or could be useful as a complement.

Another form of information asymmetry arises when the benefits of a technology are intangible. If the benefits are purely private, then it should be left to the private sector to market the product and see if it sells. But if adoption of the technology would have positive social spillovers, as with a biocontrol for aflatoxin in grain, and users will not pay for it because they cannot easily link a health or other benefit to a specific technology, then subsidization, and if necessary an ongoing public role, to ensure use may be justified. Several possible options are shown in figure 2 and the choice among them will turn in part on

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[7] Some of the complementary policies, such as pay for performance or cash on delivery aid, might also be called pull mechanisms, but the meaning here is focused on pulling innovation and the private sector.

[8] See http://haiti.usaid.gov/media/releases/20100608_gates_foundation_and_usaid_fund_to_incentivize_mobile_money_services_in_haiti.pdf (accessed May 23, 2012).

whether private sector partners are available and at which stages—development or dissemination—as well as the capacity of the recipient country government to play a role if appropriate. The role of the pull mechanism in these cases is to deliver an innovation that addresses the externalities as cost-effectively as possible and draws in private sector resources where possible, for example in scaling up production or devising a marketing campaign. In these cases, an AMC with a contract that includes a long-term supply commitment may be useful to ensure the technology will remain available after the subsidy ends.

In other cases, the problem may not be imperfect information or affordability , but social or behavioral patterns that present obstacles to adopting technologies. Time inconsistency in decisionmaking is a common problem in all societies, but in poor countries, where access to banking and other financial services is limited, poor farmers that have cash at harvest time typically do not have mechanisms to help them save now so they can invest later in next year's crop. There is a growing body of studies using behavioral economics to analyze development problems and pull mechanism designers need to factor in how consumer behavior could affect effective technology use and how those issues will be addressed, whether in the design of the mechanism itself or through the use of complementary policies. One interesting example of a complementary tool is described by Kremer et al. (2011) as a "well-timed nudge" for fertilizer use. In this experiment, fertilizer use increased by around 15 percent, compared to the control group, when farmers were asked at harvest time whether they wanted to buy a voucher for fertilizer for the next year's crop, with delivery at a time of their choosing.

Finally, consumers will rationally choose not to adopt a technology when the benefits do not exceed the costs. Here again, fertilizer is an example of a seeming paradox where many researchers find high economic returns but low rates of application of fertilizer in parts of Africa, but not always for the behavioral reasons discussed above. Zeitlin et al (2010) find that high *average* returns often mask significant heterogeneity in individual outcomes and that farmers that find fertilizer is not profitable for them stop using it. Similarly, Zerfu and Larson (2010) find that high returns to fertilizer use are usually from field studies or in households with greater wealth and human capital, allowing them to overcome the obstacles that often make it unprofitable for poorer households. A pull mechanism for an improved fertilizer would only succeed in the market if it raised benefits or lowered costs enough to make it profitable for producers currently rejecting its use. If that is not enough, donors need to identify the obstacles to take-up and find a way to address those. Cash on delivery or other performance-based aid might be more effective to address downstream market failures, such as the lack of roads or farmer education.[9]

[9] Cash on delivery aid is a proposed mechanism whereby donors and recipient country governments would agree on a common goal, such as better educating children, and then agree on a measurable, verifiable indicator

Lessons from the Pneumococcal Vaccine AMC for the Agricultural Pull Mechanism Initiative

Within a year of the release of the CGD report on advance market commitments for vaccines, the G7 finance ministers launched a consultation process to examine the idea. A year after that, Canada, Italy, Norway, Russia, the United Kingdom, and The Bill & Melinda Gates Foundation committed US$ 1.5 billion for an AMC for a pneumococcal vaccine, with GAVI and the World Bank acting as implementing partners. In late 2010, new pneumococcal vaccines were introduced in Nicaragua just a year after they were introduced in developed countries.[10] By Fall 2011, 14 developing countries had used the AMC mechanism to adopt new vaccines for pneumococcal disease years earlier than they might have otherwise and at a price well below that for similar vaccines in developed countries. Another 39 countries are expected to adopt these vaccines by the end of 2013 (Cernuschi et al. 2011)

In September 2011, a number of those involved in designing and implementing the pneumococcal vaccine AMC released a paper reviewing the lessons learned to date (ibid.). The authors note that it is too early in the experiment to fully assess the AMC 's impact in accelerating vaccine delivery and making it more affordable for poor countries, but they nevertheless thought it useful to examine the process of choosing a disease and designing the mechanism to see if there are early lessons for how to use pull mechanisms in other situations. This section discusses some of the conclusions from that report that are relevant for agriculture.

Issues around choice of pilot

The CGD report laid out the details of how an AMC could be applied either for an early stage vaccine, such as malaria, or for accelerating and scaling up production and delivery of a later stage product. While there was then, and is now with respect to agriculture, a great deal of rhetoric around the need for innovation to solve developing country problems, the donors chose relatively advanced vaccines for pneumococcal disease for the pilot. The experts committee appointed to select the disease also recommended that an AMC for a malaria vaccine would be useful as a test of the mechanism for early-stage products, but that has not happened.

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that will trigger specified payments by the donor, for example $100 per child completing primary school and taking a nationally-approved test (with the test results being made publicly available). The donor would be hands off and the recipient government would be responsible for determining the best way to achieve the goal. See Birdsall et al. (2010) for details.

[10] See the timeline on the GAVI website at http://www.gavialliance.org/funding/pneumococcal-amc/timeline/, accessed April 10, 2012.

The experts committee said they chose pneumococcal disease because it was best suited to achievement of two key donor goals: having a significant positive impact on health in developing countries, and quickly demonstrating whether the AMC tool could be valuable. But Cernuschi et al. (2011) concluded that at least two other considerations also favored selection of a late-stage product. The first was that a later-stage vaccine required a lower donor investment and the second was that more and better data was available for the later-stage products—both elements that reduced the risk for donors. Choosing the pneumococcal vaccine also entailed *political* risks, however, as some potential G7 donors who were interested in vaccines for higher profile diseases—HIV/AIDS, malaria, or tuberculosis—ultimately declined to support the initiative.Others criticized the choice for aiming too low and achieving too little. Assessment of those allegations will have to await the impact evaluations due in future years that will determine whether the AMC was a cost-effective intervention to speed the delivery and lower the cost of new vaccines for developing countries.

While the choice of pilots for the Agricultural Pull Mechanism Initiative had not been announced as of the time of writing, indications are that it will follow in the steps of the pneumococcal vaccine and focus on later-stage technologies (see below). As with the vaccine AMC, however, the steering committee risks failing to stimulate broad donor interest if it focuses on "easier," but also less ambitious, less innovative, solutions. Since the initiative is intended to test and then evaluate the value of pull mechanisms in agriculture, it would be useful if the steering committee selected technologies at both early and late stages of development, as the experts committee recommended for vaccines.

Mechanism design issues

There are some issues around mechanism design for agriculture that will be similar to those for vaccines, but others that are quite different. And, whatever stage of innovation is the focus, there are additional challenges in agriculture. Whereas the vaccine AMC focused on solving market failures on the supply side, the final consumers for agricultural innovations are often dispersed in remote rural areas where they are difficult and costly to reach. making careful attention to delivery, adoption, and other supply chain issues relatively more important.

Uncertainty regarding the potential demand for products is *not* one of the differences, however, and the need to coordinate push and pull subsidies so as to avoid overpaying for innovation, particularly when the private sector is involved, is also an issue for both sectors. At the same time, the political sensitivities related to subsidizing "deep-pocketed" multinational corporations that arose in the vaccine case seemingly have been replaced by the challenge of where to find venture capital for the commercialization of agricultural innovations. Another potential difference between a pull mechanism for agriculture and the

AMC for vaccines, where donors wanted a long-term, contractual supply commitment, is the donor desire in the former case to build in market sustainability.

Addressing private sector concerns about the uncertainty of demand for vaccines played a major role in both the CGD report on an AMC for vaccines, and in the specific design of the pneumococcal vaccine AMC. Because of the feedback received as the working group developed its report, CGD launched a second initiative to develop better demand forecasting tools that could be used in the context of the AMC mechanism, but also to improve the predictability of vaccine supply in general (CGD 2007). In the pneumococcal vaccine pilot, after negotiations with potential suppliers, the final AMC design included a minimum purchase guarantee to assuage the concerns about potential shortfalls in demand, even though that somewhat weakened the incentives for suppliers to compete for market share by continually improving the product. The difference with agriculture, then, is not in the uncertainty regarding demand, but in the additional issues raised by weak infrastructure and underdeveloped supply chains in rural areas.

A key difference between the vaccine AMC experience and the agricultural pilots being considered is that the relative scarcity of deep-pocketed private sector firms becomes a design challenge, rather than a political problem as it was with vaccines. In adapting the original AMC concept to the agricultural sector, the idea of leveraging private sector resources for both innovation and the task of marketing and ensuring adoption of the product seems to have run into the reality of small firms with shallow pockets and constrained access to capital. In such cases, it may be difficult to balance the donor's desire to align incentives from innovation through product development and delivery, by paying only on delivery, against the innovator's need for capital to invest in production capacity or supply chain development. Alternatively, the pilots could look for complementary mechanisms to address the finance issues, or perhaps consider allowing producers to borrow against the prize or advance market commitment, but on terms that ensure they share the risk involved.

A final design issue related specifically to adapting the AMC idea to agriculture is whether an explicit long-term supply commitment is needed. In cases where social externalities are limited and the private gains from technology consumption are large relative to the public gains, using a pull mechanism to create a market that can be sustained without subsidies is the ultimate goal. In those cases, a long-term supply commitment should not be necessary. In the cases noted above, where the consumer benefits of the technology are unobservable and the social externalities are large, then continued subsidies as well as a supply commitment to ensure sustainability may be helpful.

What Does the AGPM Initiative So Far Tell US about Pull Mechanisms?

The website on the Agricultural Pull Mechanism Initiative, hosted by the World Bank office for Concessional Finance and Global Partnerships, provides background on pull mechanisms generally, as well as brief summaries of the six potential pilots that were selected by the steering committee for further development.[11] Those six, based on recommendations from an expert advisory group, were culled from more than three dozen ideas generated by groups of technical experts in four areas: inputs and increasing yields; outputs and post-harvest management; livestock; and nutrition. Table 1 summarizes key elements of the short list of potential pilots, but note that all of the pilot designs have been developed further since this information was posted. It is provided here as being indicative of the issues with which supporters and expert advisers are grappling.

One tendency suggested by the summary of potential pilots is that donors are perhaps overly risk averse, in what they are willing to fund, at least in this initial phase. Conversations with some of those involved in developing the proposals suggest that the first three—biofortified staples, on-farm storage solutions, and the biocontrol for aflatoxin—will be the pilots chosen for the initial stage. All target the broader dissemination and uptake of technologies that already exist, though the pilots may also include incentives for adaptation or modest additional innovation to extend the uses of some products. By contrast, the other three would be higher risk and longer to come to fruition, but also potentially have a higher pay-off. Perhaps, as with the vaccine AMC, the short timeline for reaching decisions and the desire to show results quickly may be discouraging donors from being bold and aiming for more innovation.

At the same time, the (sparse) information that is publicly available on mechanism design suggests that donors are having problems finding potential private sector partners that are willing and able to accept risk, perhaps because they lack access to capital. In the early stages, the proposals all included prizes or other rewards at two or more stages of the process. If there are different actors involved at the innovation, product development, or marketing stages, the mechanisms could fail to align incentives or resolve information asymmetries. In that case, product developers do not have the same incentive to do the market research to increase chances that the product can pass a market test. Donors could end up paying for a product with disappointing adoption levels or that does not deliver the desired results. The structure of the proposals also suggests there will be relatively little leveraging of private

[11] See http://web.worldbank.org/WBSITE/EXTERNAL/EXTABOUTUS/ORGANIZATION/CFPEXT/0,,contentMDK:23005969~pagePK:64060249~piPK:64060294~theSitePK:299948,00.html, accessed March 13, 2012. The summaries of the six potential pilots seem to have been removed from the top of the page, but versions remain in the longer lists of concepts developed by thematic groups at the bottom of the homepage.

sector resources. These elements together raise questions about the sustainability of the pilots.

Table 2 Potential Pilots for Agricultural Pull Mechanisms			
Technology	**Basic design**	**Is new product innovation pulled?**	**Potential for market sustainability**
Biofortified beans, cassava, maize, and sweet potato (Africa)	Prizes for multiple partners at different stages of supply chain	No, proposal addresses "delivery" of varieties developed with public funding	Unclear
On-farm storage (Africa)	"Upfront" prize for top three entrants; proportional prize, or per unit subsidy for adoption; final prize for technology with greatest impact	Depends on details, but proposal sets as goal to "lower the price" of storage technologies (most likely hermetically-sealed bags, silos)	Yes
Biocontrol for aflatoxin (Africa)	Prize for scaling up production; pay for performance for reduction in aflatoxin prevalence; per unit premium for aggregator purchases of aflatoxin-free grain	No; proposal is to "incentivize and facilitate use of Aflasafe™" product	With public role in delivery/adoption as for human vaccines?
Improved vaccine for small ruminant disease (PPR) Improved delivery of vaccine (Africa)	Prize for vaccine (early or late-stage possible); AMC or pay for performance for adoption Pay for performance (or purchase guarantee?)	Depends on choice to support early or late-stage vaccine No	With public role in delivery as for human vaccines? Unclear
More efficient fertilizer production process (global) and Improved product, better adapted for smallholders (Africa)	Prize for process or product meeting criteria; per unit subsidy to lower price and encourage adoption by smallholders	Yes, if prize for new process/product; less so if subsidy for smallholder adaptation of existing fertilizers	For production, yes; for increased smallholder use, unclear
Improved hybrid rice variety (S. Asia)	Prize for new hybrid; "progressive" prize to encourage adoption	Yes	Yes

Conclusions and Recommendations

Given the scope of the challenges outlined at the beginning of this paper, one might wish for more ambition from donors, if not in this initial round of pilots then in a later phase. Donors are funding research into more stress-tolerant and productive varieties of key staples, but they are mostly doing so with traditional push funding. In the spirit of experimentation, it would also be useful to think about how the venture capital issues might be creatively addressed while retaining the advantages of paying for outcomes, at the end of the process, rather than paying for intermediate outputs at various stages. Finally, donors should be looking to embed pull mechanisms in broader rural development strategies to address the missing, incomplete, and imperfect markets that all too often make investment in technology unprofitable.

For the short run, there are a number of worthy candidates for investment in the list of potential agricultural pull mechanism pilots and some intriguing ideas for how to design them under difficult conditions. What is perhaps most notable is that all of the collaborators in the initiative are emphasizing the need for well-designed monitoring and evaluation throughout the process. If nothing else, donors hope to gain knowledge about what works under what conditions—and that is essential to innovation in aid delivery.

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Figure 1: Incentive Programs by agents and objectives

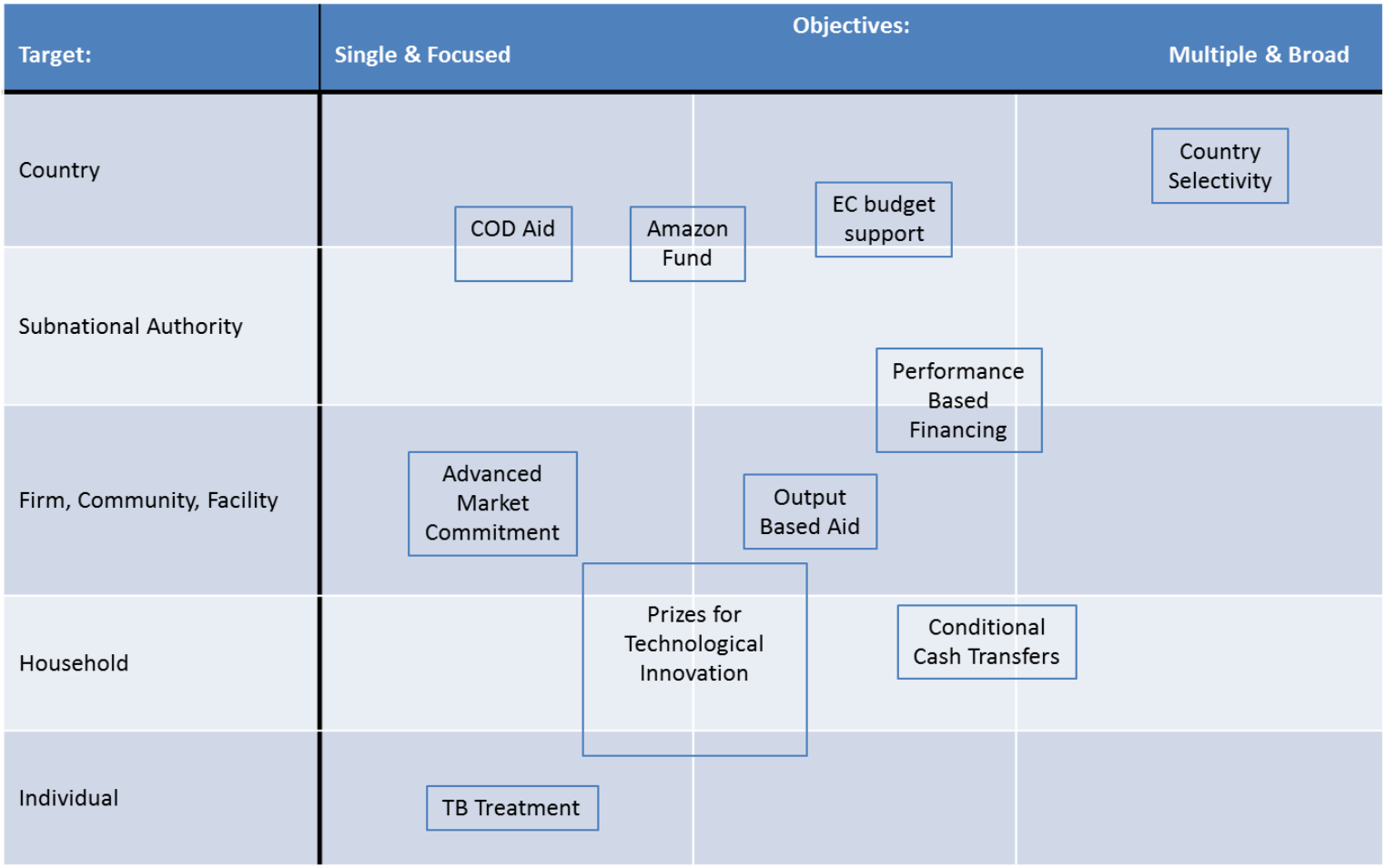

Figure 2 Using pull mechanisms to promote technology adoption in developing country agriculture