AGRICULTURAL TECHNOLOGY ADOPTION & FOOD SECURITY IN AFRICA EVIDENCE SUMMIT

EVENT BRIEF

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TECHNOLOGY AND AGRICULTURAL PRODUCTION IN AFRICA

Derek Byerlee (SPIA)

This lecture was intended as an overview of the relationship between technology and agricultural productivity, setting the tone for the topic of the Evidence Summit. In the lecture, Byerlee spoke about how little evidence there is of a productivity take off, and that the scale of technology adoption is often quite small and localized. Byerlee noted that it is important that efforts are not solely focused on food staple technologies or on yields. Rather, Byerlee said, the focus should be on labor productivity, like labor saving mechanization, and a diversity of conditions and technologies. Furthermore, Byerlee said that investments should be made in generating more and better technologies along with enabling policies and institutions for adoption. These types of technologies, according to Byerlee, hold the potential for socio-economic transformation of Africa's agricultural sector.

BARRIERS AND CONSTRAINTS TO AGRICULTURE TECHNOLOGY ADOPTION IN AFRICA

Chris Udry (Yale)

This lecture revisted the question at hand, "Why has agricultural technology adoption and diffusion in Africa lagged behind that of other areas in the developing world?" The lecture served as a lead-in to the panels of the Summit, explaining that presenters would propose a new path for accelerating adoption and diffusion of technologies. In the lecture, Udry used the example of organic and inorganic fertilizer to illustrate ten barriers and constraints of agriculture technology adoption in Africa. The barriers include:

1. Risk
2. Complementary inputs/systems
3. Social/cultural constraints
4. Supporting markets
5. Information/training
6. Yield/profit shared among many people
7. Yield/profits distributed across time
8. Negative spillovers
9. Variability due to microclimate/agro-ecological characteristics
10. Cooperation needed

PROFITABLE AGRICULTURAL TECHNOLOGIES: EVIDENCE FROM THE FIELD

The purpose of this first panel was the presentation and discussion of selected technologies with demonstrated impacts on increased productivity and income among African farmers.

Michael Kremer (Harvard)

Michael Kremer presented on fertilizer technologies implemented in Kenya. Kremer began by explaining the two views on fertilizer, the Agricultural Expert View, and the "Chicago View". According to Kremer, the agricultural expert view contends that fertilizer is critical to productivity and that many developing-country policymakers see heavy fertilizer subsidies as critical to raising agricultural productivity. Alternately, Kremer notes, the "Chicago View" contends that farmers are rational and profit maximizing, that the

conditions on test plots are not realistic, and the overuse of subsidies induces serious distortions. The Chicago view has long been dominant in causing the rollback of fertilizer subsidies, however, as Kremer noted, there has been a resurgence of the agricultural expert view. Kremer then explained the context in Kenya: that in the study area only 20-40% of farmers used fertilizer in any given season and although the farmers said they wanted to use fertilizer, they lacked the money to purchase it. Kremer presented two technologies used in Kenya: SAFI fertilizer and the "BlueSpoon" kitchen measuring spoon—painted blue—that helps farmers use the optimal quantity of fertilizer half a teaspoon per planting hole. Kremer explained that the experiment encouraged farmers to share agricultural practices in cooperative meetings, thus reducing the cost of communication. The evidence from Kenya, according to Kremer, suggests that small, time-limited discounts are better than large persistent subsidies, the cost of holding meetings is very small (an alternative is radio announcements), and that by sharing knowledge at community meetings, adoption will spread.

Shawn Cole (Harvard Business School)

Shawn Cole presented on innovative financial products and services, specifically indexed insurance. His presentation included evidence from India on microinsurance (rainfall insurance) and household risk management. Cole explained that when returns are properly adjusted for risk, index insurance is (or can be) a profitable agricultural investment. Additonally, Cole noted that index insurance may also facilitate other profitable investments, in particular those whose returns co-vary with rainfall. Coel reported that research conducted in India confirmed the hypothesis that farmers are less likely to invest in cash crops due to rainfall risk. This shows, according to Cole, that rainfall insurance increases small farmer investment in cash crops. Cole listed three research questions for the field experiment conducted in India that are important in determining the profitability of new technologies and innovations:

1. What key frictions/factors constrain widespread adoption of this type of index insurance product?
2. How does insurance affect household decision-making and risk-taking (investment, crop mix, etc.)?
3. How well does the insrance help smooth consumption ex-post after a bad outcome (i.e a sever drought)? Does formal insurance crowd out informal risk-sharing?

Dan Gilligan (IFPRI)

Dan Gilligan presented on measuring the nutritional impacts of biofortified sweet potato in Mozambique and Uganda. He presented findings of evalutation of a project to disseminate provitamin-A-rich orange-fleshed sweet potatoes (OFSP) to reduce vitamin-A deficiency, specifically the scope of OFSP adoption, the share of planted SP area, the impact on dietary intake of vitamin A, and the role of social networks in OFSP adoption/diffusion. Gilligan also discussed the implications for cost effectivemess and scaling up. According to Gilligan, the project was successful in promoting OFSP in Mozambique and Uganda, it also increased the share of OFSP in sweet potato areas cultivated, and many households substituted OFSP's for white or yellow SP. Gilligan said that the project successfully increased vitamin A intake of young children. Additionally, Gilligan noted that social networks play an important role in diffusion of the OFSP technology beyond treated households, as neighbors of treated farmer group members were 23% more likely to adopt OFSP if there is at least one treated farmer in their social network.

Promising Agricultural Technologies: What Evidence Do We Need on the Profitability of New Technologies?

The second panel presentation and discussion focused on how to generate more evidence on the profitability of new technologies. It also addressed the question of what evidence is necessary for

decision-making, as well as the issue of how the heterogeneity of local agro-ecologies can be incorporated into decision-making.

Rachel Glennerster (J-PAL)

Rachel Glennerster introduced the topic of the panel and the panelists. She mentioned what each of the panelists would be presenting on, and how these presentations not only linked together under the topic of evidence need for the profitability of new technologies but also their importance in the larger topic of agricultural technology adoption in Africa.

Florence Kondylis (World Bank)

Florence Kondylis presented on The World Bank's AADAPT Project—a network of policymakers and researchers that works with operations at scale, using country systems, covers a wide range of themes, and mobilizes large numbers of stakeholders who have adopted evidence-based policymaking. According to Kondylis, the project has an open platform for partners to join in. Kondylis said that AADAT can also mobilize governments on key development issues/innovations because it has convening power, it is present on the ground, and it provides a bridge between research and policy. Additionally, Kondylis said, in working to design, implement, and test alternative interventions to narrow the gender gap, the AADAPT project covers the thematic areas of access to better technologies, rural infrastructure management, accesss to land, access to markets, and rural livelihoods and local governance. Kondylis also talked about the multiplier effect of AADAPT on the gender experience: designing and testing strategies, and scaling up what works for men and women, allows for higher gender inclusion in DIME-supported projects like AADAPT.

Jeffrey Ried (Gates Foundation)

Jeffrey Ried presented on the role that evidence on the profitability of new technologies plays in the decisions of donors. Ried explained that the Gates Foundation's work is guided by a few core principles – farming is a way to address both hunger and poverty – put small farmers—most of whom are women—at the center of efforts, focus on crops and livestock of greatest need, focus relentlessly on results, build strong partnerships, and lastly, work across the full agricultural value chain. According to Ried, the Gates Foundation follows a process of

1. **Understanding** the problem; understanding success – *From vagueness to a common perspective*
2. **Discovering** potential solutions – *From no or few options to many options*
3. **Identifying** solutions with the right characteristics – *From many options to rational selection*
4. **Interacting** between components – *From simple understanding to understanding complexity*
5. **Simplifying** the solution – *From complexity to predictable outcomes*
6. **Replicating** the solution – *From predictable outcomes to building success*

Bekele Shiferaw (CGIAR)

Bekele Shiferaw presented on behalf of Marianne Banziger on the evidence that is necessary in determining the profitability and adoptability of new technologies. Although there is some evidence on the profitability of maize and other crop varieties in Africa, Shiferaw noted that there is a need for a broader view of profitability, looking specifically at ‗adoptability'. According to Shiferaw, reliable evidence needs to be generated on the profitability and adoptability of agricultural technologies, as well as the constraints upon adoption. The current challenges in estimating profitability of new technologies, reported Shiferaw, are that yield and cost estimation are dependent on cross-sectional small sample and recall surveys, there is no actual measurement of land area, yield and input use, there is poor representation, and the data on risk and inter-seasonal yield variation is poor. Shiferaw presented some solutions that have been

suggested: panel surveys with repeated visits, actual measurement of land area, yield and key inputs (e.g. fertilizer), representative sampling to capture variation in agroecology, markets etc, and capturing the effect of weather and growing conditions. Shiferaw also presented ideas for generating reliable evidence on the adoption constraints for new technologies such as conducting regional on-farm trials for promising varieties, and conducting technology adoption and impact studies.

Gender and Agricultural Technology Adoption

The third panel focused on the role of women within African agricultural systems, discussing the role of gender in technology adoption and diffusion.

Nava Ashraf (Harvard Business School)

Nava Ashraf gave an overview of the role of women within African agricultural systems. Ashraf noted the disparity between women's responsibility for food production and actual female ownership of land, women's lack of access to resources as inhibiting efficiency, and the lack of female authority in household agricultural decisions. Ashraf used the example of contraception adoption to illustrate the interaction between information and technology adoption in the household and how it can result in female empowerment. Ashraf also touched on the topic of microfinance and savings also playing a role in the empowerment of women.

Barbara Bamanya (AGRA)

Barbara Bamanya presented on the access to information and inputs of women in African agricultural systems. Bamanya talked about the unleveled field for women farmers, uneven incentives, and gaps in development assistance to women farmers. Bamanya noted that women farmers have smaller plots of land than men, they are less likely to us advanced technologies, they are less likely to purchase inputs (e.g. fertilizers), there is less incentive for them to invest in soil fertility and they may obtain less output than men. According to Bamanya, there are several things to be done in order for circumstances to improve for women farmers in Africa:

1. Improve access to resources (land, fertilizers, improved seeds, extension and financial services)
2. Improve incentives – put the income into women's hands
3. Advocate for increased investments in small and women farmers
4. Conduct better baseline surveys of households and communities before introducing new technologies – this may help predict how they may be affected by the introduction of new technologies.
5. Address both gender-specific bottlenecks and gender neutral obstacles incurred during the provision of extension services
6. Consider the local cultural norms that influence the male-female interaction
7. Schedule extension services that take into consideration women's childcare and housework schedules

Cheryl Doss (Yale)

Cheryl Doss presented on the issue of land rights, women's access to assets, and technology adoption. She presented two sets of issues with technology adoption. The first issue Doss presented was that of adoption: Who adopts? How do we promote good technology and its adoption? The second was about the effects of technology adoption: How do we make sure that new technologies do not leave groups worse off? It is possible that they may not adopt the technology and additionally may lose access to

resources. A theme interwoven into the two issues presented by Doss was how these issues differ for men and women. Doss reported that in Ghana, interviews conducted of maize farmers revealed that fewer women than men adopted improved technologies (seed and fertilizer). Doss noted that although women have claims to land and are reported as owners, they have fewer rights over this land (rights to sell, bequeath, or rent), are less likely to have their names on ownership documents, and are more vulnerable to lose their claims to land when the household dissolves. Doss then explained the importance of collecting more data on the individual level rather than the household level, as well as the need for more information on women's claims to land in order to predict and evaluate impacts of new technologies.

Emily Hogue (USAID)

Emily Hogue presented on a tool for measuring women's empowerment, the Women's Empowerment in Agriculture Index. According to Hogue, the index will be ready to launch by early 2012, with performance monitoring in all FTF countries for impact evaluation. Hogue explained that the first-level objective of Feed the Future is inclusive agricultural sector growth; "Inclusion" then means "empowered." Hogue explained that because empowerment is a multi-dimensional concept, the tool measures several dimensions. Hogue listed the five domains to be measured by the index:

1. Women's role in household decision-making related to agricultural production
2. Women's access to productive capital, such as credit or land
3. The adequacy of a woman's income to feed her family an adequate diet
4. Women's access to leadership roles within the community
5. Women's and men's labor time allocations

Strategies for Increasing Adoption of Profitable Agricultural Technology: Risks, Savings and Finance

The fourth panel discussed evidence on the role of financial services access in technology adoption and diffusion.

Michael Carter (UC Davis)

Michael Carter presented on the use of savings, credit and insurance to bridge yield and income gaps of small farms. His presentation included ideas and evidence from Mozambique, Ethiopia, and Mali. Yield and family income gaps remain a predominant feature of the small farm landscape. Carter spoke about index insurance in the adoption of agricultural technologies, using evidence from the BASIS program in Mozambique. Carter noted that index insurance does not make payouts based on specific individual losses. Rather, Carter explained, payouts are made when a triggering event, which is correlated with losses, occurs.These triggers, according to Carter, include: (1) average yields fall below 80% of the long-term average, (2) satellite images show poor vegetation growth and predict crop (or livestock) losses below the critical level, and (3) rainfall patterns predict significant decline in crop yields. According to Carter, index insurance preserves effort incentives as „delinquent" behavior does not increase the likelihood of insurance payoff, additionally an adverse selection does not matter as the likelihood of payouts is not influenced by the riskiness of those who buy. Carter also spoke about securing finance for technology adoption in Ethiopia, and moving forward from protection to growth in Mali. While it is very important to invest in new agricultural technologies, Carter explained that it is crucial to find ways to realize the underutilized potential of already existing agricultural technologies.

Xavier Giné (World Bank)

Xavier Giné presented on the commitment to savings, specifically a field experiment from rural Malawi. According to Giné, the motivation for commitment savings is that the returns to saving and investment are high in many developing countries. Giné gave the example of sub-Saharan Africa where fertilizer is one of the highest-return and most under-exploited investment opportunities for smallholder farmers. The hope, Giné said, is that by insuring farmers against adverse events through rural finance, farm output will increase. Giné explained that insurance against adverse events includes: (1) providing insurance against poor rainfall, (2) facilitating credit for agricultural inputs, (3) improving repayment via biometric identification, (4) encouraging farmers to save for their own input purchases, and (5), facilitating access to ordinary and ~~-c~~ommitment" savings accounts. Giné nothed that although in practice commitment savings allow customers to put funds into a special account where their access is restricted for a defined period, and customers can choose the ~~-r~~elease date" of funds, these households are then less able to respond to shocks. Giné added that it is unknown what the net impact of commitment facilities is on household well-being. Giné explained that findings from Malawi were that the offer of commitment savings accounts has substantial impacts on both savings prior to the next planting season and key outcomes in and after the next season (agricultural inputs applied, crop output, household expenditures). According to Giné, commitment savings offers positive implications for welfare impact, since households have funds available to cope with shocks. Furthermore, Giné noted that the demand for commitment may stem from a desire to shield funds from one's social network.

Michael Kremer (Harvard)

Michael Kremer presented on the topic of collateralized loans. Kremer spoke about new credit approaches to encourage technology adoption, specifically in the case of rainwater harvesting in Kenya. The study Kremer spoke about was located near Nyahururu, in the Central and Rift Valley provinces of Kenya focusing on rainwater harvesting and its economic benefits on the dairy industry. Kremer noted that the dairy industry accounts for 3.6% of GDP in Kenya and involves about 1 million small scale farmers. 56% of milk is produced by small holders with 1-3 cows. Kremer then explaind the benefits of tanks and rainwater harvesting, noting that they are important for both cows and people, and that they save time—especially for women. Additionally, Kremer said that water tanks make good collateral because they are extremely large and hard to move or hide, they are only useful to people at their homes, and they are very durable with a good second-hand market. Kremer also noted that with support from the Financial Sector—who works closely with banks to improve financial access—deepening, Heifer International is scaling the Nyala dairy cooperative model across East Africa. Kremer concluded that technology is in extremely high demand, but it is very expensive, and while farmers do seem to be credit constrained, they have a strong preference for collateral that is not social (i.e. not through guarantors). This preference for non-social collateral, Krmer reports, points to the potential for collateralized loans within the arena of technology adoption.

Working Group 1: Evidence

The first working group was centered on the topic of evidence; groups discussed new and ongoing programs of USAID mission staff and other practitioners in the group, and identified specific technology adoption (or profitability) challenges in the field including key questions that needed to be answered.

STRATEGIES FOR INCREASING ADOPTION OF PROFITABLE AGRICULTURAL TECHNOLOGY: ROLE OF POLICIES, INSTITUTIONS, SOCIAL NETWORKS, AND INFRASTRUCTURE

The fifth panel discussed evidence of various policy, institutional, and community-based strategies for increasing the rate of technology adoption and diffusion in Africa. Evidence was drawn from both the public and private sectors.

Mywish Maredia (Michigan State University)

Mywish Maredia presented on technology supply vs. effective demand, the facts and reality. Maredia noted that in many African countries, the increasing supply of new technologies meets decreasing acceptance by producers, and the growing evidence of profitable returns to research investments is increasingly countered by studies that show that technologies are not profitable to end users. Maredia also noted that in recent years, as a result of the growing donor pressures to demonstrate impacts of agricultural research, several studies have been conducted to document impacts and estimate rates of return (ROR) to research investment in Africa, and with the exception of a few cases, most impact studies report high ROR (above 12%) to agricultural research investments in Africa. Additionally, Maredia said that low effective demand for technology by African farmers implies that a technology developed by the research system: does not reach the end users, is not affordable to them, and has not proven profitable for them. The influences on ~~-e~~xpected profitability" of technology, Maredia said, are the uncertainty of variables that determine the profitability outcome (e.g. input and output prices), and the probability that the technology will yield a minimum level of net revenue. Both technological considerations (e.g., performance and adaptability of technology) and non-technological considerations (institutions, policies, infrastructure, social networks, etc.) play important roles in the realization of profits and the decision to adopt or not to adopt a technology, as Maredia noted. Maredia concluded that improved policies, infrastructure and institutions minimize risks/uncertainty and increase the probability of realizing higher profitability from adopting a technology.

Duke Burruss (DAI)

Duke Burrus presented on market development, supply chains, and private sector linkages. According to Burruss, the relationship drivers to market access, supply chains and private sector linkages are demand, capacity/scale, mutual benefit/value, mitigating risk, and service/technology. To illustrate how innovations like ‗commercial frameworks' that link farmers with private sector partners and associated infrastructure development, help in mitigating risk and technology adoption throughout the value chain, Burruss used a case study from Ghana. The Ghana project, Burruss explained, was designed with 3 Regional packhouses with grower/exporter as operator, and a vetting process up front, as well as 10 Agribusiness Centers with firms (active in value chain) as operator. Burruss reported that the project attracted the private sector and leveraged irrigation investment where VegPro (Kenya) co-located and the packhouse equipment loan program attracted Chiquita. Some key factors Burruss mentioned were: willing stakeholders, a demand driven value chain, viability, land conveyed, shareholders agreements (private sector and smallholders), and business relationships. In terms of timing, Burruss noted that the commercial framework (the soft side) needs to be in place first for sustainability, and then the works (the hard side) will fall into place.

Norman Uphoff (Cornell)

Norman Uphoff presented on experience with multi-sectoral strategies for disseminating a proven agricultural technology, using the example of the System of Rice Intensification (SRI) in Madagascar. Uphoff explained that leadership in dissemination strategies can come any of many different sectors; with other sectors then drawn into a collaboration. The sectors Uphoff mentioned include: government agencies, research institutions, NGOs, universities, the private sector, farm/village groups, international institutions, and individuals. According to Uphoff, the dissemination of SRI has been an unusual and unprecedented innovation. Uphoff noted that SRI is often hard to accept because it does not require any change in the rice variety used or an increase in external inputs. Uphoff explained that SRI methods improve the yields of all rice varieties evaluated so far: modern and traditional, improved and local. Uphoff used the Initiative in Kenya as an example: SRI use expanded from 2 farmers in August 2009 to 264 farmers in March 2011, with growing farmer demand for training, yields were raised from 5-6 tons/ha to 6-8.5 tons/ha, water use was reduced by 25% and the net income/ha of farmers was 28% higher. Lastly, Uphoff explained the principles guiding the multi-sectoral approach to technology dissemination which include: more flexible funding, inclusiveness (integrating those who want to work along with the innovation), knowledge of the terrain (who is already working there/what are they doing?), investing in collaboration with government services, identifying complementarity with others, expecting accountability for results instead of preoccupation with process.

Ruth Vargas Hill (IFPRI)

Ruth Vargas Hill presented on cooperative insurance and informal groups. The presentation included evidence from a field experiment in Ethiopia. Using the example of Ethiopia, Hill explained that risk is prevalent in rural Africa and seems to constrain technology adoption. Because of uninsured weather risk, Hill said that insurance innovations offer potential, one such innovation is weather index insurance that pays on the basis of an observable index rather than on losses and individual experiences. According to Hill, by linking insurance payments to an easily observable index, index-based insurance avoids adverse selection and moral hazard problems and has lower administrative costs. However, Hill noted that early field experiments so far have not lived up to expectations as there has been a low demand for insurance likely largely determined by basis risk, particularly for farmers that are risk averse, and basis risk reduces the quality of the products, making them expensive for what they promise. Hill brought up the question of whether index insurance can be used as a tool to transfer large covariate shocks (extreme shortfalls in rain) away from groups, and still encourage group members to share smaller agricultural risks among themselves. Hill explained the findings of the study in Ethiopia that introduced an individual index-based rainfall insurance in rural Ethiopia, wherein policies were marketed through pre-existing risk-sharing groups (primarily funeral societies called iddirs) and selected leaders were trained in general concepts of insurance and the details of the products. In looking at the impact of training allocation on demand within the group, groups with trained leaders were 78% more likely to purchase an insurance policy, and the average number of insurance policies purchased per person increased from 0.36 to 0.77, Hill reported. Hill concluded that the study suggests that there is substantial potential for using index insurance to insure groups, when groups are cohesive and high-functioning.

Strategies for Increasing Adoption of Profitable Agricultural Technology: Extension, Training and Information Innovations

The sixth panel focused on the role of public and private sectors in extension and discussed the potential of modern approaches to promoting new technologies.

Paul Hixson (University of Illinois)

Paul Hixson spoke briefly about the USAID funded project MEAS (Modernizing Extension and Advisory Services) and about how effective extension programs work. Hixson explained that effective extension programming begins with effective communication, and that following the communications chain from sender to message to channel to audience to finally the effect is not an effective communication. According to Hixson, simply adding feedback from the effect back to the sender completes the communication cycle, creating a circle of successful communication. Hixson spoke about some of the major lessons learned:

1. It is important to always put audiences (farmers) first: listen to them – discover what they want to do and what they want to learn, discover what gaps exist in their current knowledge, discover their preferred methods of communications, and lastly, discover who they trust.
2. Base all plans and actions as an information provider from the point of view of being a helpful, respectful partner in a 2-way communications process – farmer audiences will sense the difference and respond accordingly.

Hixson concluded that the ICT landscape is changing rapidly and that although new ICT tools may be in use, it is important to still engage in good communication principles.

Jeremy Magruder (UC Berkeley)

Jeremy Magruder presented on an extension experiment, specficially about choosing extension partners. Magruder's presentation addressed the question: Can extension leverage peer learning? Magruder reported that farmers learn about technologies in several ways, including direct trainings and conversations with extension agents, and learning from peers who have tried new technologies or have at least been trained to use them. It is evident that training one farmer has the potential to influence many, the question to research, according to Magruder, is at what point this multiplier is the highest. On the issue of integrating networks into extension, Magruder notes that there are two important factors that determine which farmer partners will induce the greatest adoption, however there is little knowledge on them. The two factors Magruder spoke about were: which peers farmers actually learn from, and how the farmers learn. Magruder presented results from the project in Malawi wherein social connections were mapped out through a census, then the ~~b~~best" partners were chosen to work with, and finally adoption with the ~~b~~best" partners was compared with partners chosen by pre-existing extension methods. Magruder reported that the project found that success is a very persuasive factor in adoption, however persuasion is difficult. Magruder touched on the issue of breadth or depth, which depends on both technology and context: whether the goal is to expose many people slightly, or a few at a great intensity. For the future, Magruder spoke about learning whether academic results on social learning (and general intuition) can be leveraged by policy.

Paul Roberts (ForgetMeNot)

Paul Roberts presented on information and communication technologies and whether they will really meet expectations. Roberts reported that basic interactive information messaging is making a difference in some areas. The examples Roberts used include: agricultural market price information via SMS, medical information via mobile phone, and mobile financial services. According to Roberts, GNAFF extension officers have been able to share information with farmers through two-way instant communication. Roberts noted that there are real savings in cost and time through the usage of mobile phones for transferring information because at present, many people wanting access to the trove of information found online must use cafes because internet access around Africa is unreliable and expensive. The demand for simple products and services that can potentially make a difference in agricultural

communities is huge but Roberts notes two problems: little awareness of alternative products and tools for self-help, and little access to information to be able to make informed decisions. Roberts explained that providing access to the service may be more valuable longer term than the immediate outcomes of the service itself. Additionally, when the end user individual or group takes ownership of the process for interacting, sustainability may be increased. Roberts concluded that the potential exists to merge hands on, face to face interaction with communications technology to reinforce and efficiently enable the diffusion of information and activities that can improve farm incomes.

Burton Swanson (ATMA)

Burt Swanson presented on modernizing extension, specifically transforming extension systems within a rapidly changing global economy. According to Swanson, the key functions of an effective comprehensive agricultural extension system are:

1. Maintaining national food security – transferring technology, especially for staple food crops.
2. Improving rural livelihoods – training farmers how to intensify and diversify their farming systems, increasing farm-household income by helping small-scale men and women farmers learn how to produce and market high-value products, and training rural women how to improve family nutrition and use improved family planning, hygiene and health care practices.
3. Process innovation –training farmers how to organize into producer and self-help groups, building social capital.
4. Product innovation – training farmers how to use sustainable NRM practices.

Additionally, Swanson said that key to helping small-scale farmers increase their farm income is: expanding high-value markets, identifying innovative farmers, organizing self-help groups, conducting farmer-to-farmer assessment, training interested farmers, and developing market chains. According to Swanson, public extension should give higher priority to process innovations that will enable small-farm households to increase their household income. Swanson said that public extension must also give high priority to natural resource management (NRM) practices. Swanson explained that to make these institutional changes, public extension systems must become more decentralized, farmer-led and market-driven, and to make this transformation, strategic investments in public extension will be needed. Finally, Swanson said that public extension systems must also become financially sustainable (different alternatives are possible).

Working Group 2: Technology Assessments Tool

The second working group consisted of review discussion of the Technology Assessment Tool. The questions addressed by groups were:

1. Is this tool useful?
2. How would you use it?
3. Does it deal adequately with local context and agro-ecology?

Strategies for increasing Adoption of Profitable Agricultural Technology: Interventions for Women and Girls

The last panel discussed the evidence on strategies to enhance women‘s technology adoption and access to information.

Markus Goldstein (World Bank)

Markus Goldstein presented on the disadvantages of women in agriculture, what can be done about gender inequality. Goldstein explained that there are several disadvantages to women that play a role in their adoption of technology, including: less access to land, and less secure land when they do have it, less access to fertilizer, lower access to labor, worse human capital, less access to credit, and worse access to extension. Goldstein noted that it is not completely clear whether or not women and men are benefitting equally from technology adoption because most studies do not have enough statistical power to give adequate results.

Roger Salway and Andrea Brovold (Compatible Technology International)

Roger Salway and Andrea Brovold presented on a technology that speeds the work of women and girls. Salway explained that technologies that are affordable, use local parts and labor, are manually powered, culturally compatible, and sturdy, are appropriate for the developing world. Technologies that use diesel or electric power, are built for large farms, need maintenance, and are expensive, Salway noted, are inappropriate technologies for the developing world. According to Salway, experiments show that CTI Grain Processing Prototypes are extremely effective in eliminating much harvest millet loss—they decrease the harvest millet saved to lost ratio from 42%/58% to 92%/8%—there are challenges to indrocuing the new technology. The challenges that Salway described include:

- post harvest implications – coming up with a plan for the challenges that farmers face after harvest is necessary
- cultural/social acceptability – training farmers and collaborating with communities

Salway also noted the issue of funding in order for the technology to proceed on its way to adoption. According to Salway, this funding will allows the following order in the leadup to adoption of the technology: assessment, idea and prototype development, field testing and a pilot program, training development, follow-up and data collection, business model development, established manufacturer/distributor, and finally deployment to development programs.

Chris Udry (Yale)

Chris Udry presented on high value crops as a valuable technology for women and girls. Udry noted that because both adoption choices and welfare outcomes are consequences of household processes, the question of equilibrium is unavoidable, especially how resources are allocated within the household. Udry then compared the differences between „efficient" and inefficient households: „Efficient" households are sensible – they don't waste resources – they are compatible with bargaining and have complex power dynamics, they have strong implications for adoption and will use a technology if it makes their household better off as a whole. However, Udry noted, these points do not imply that something that improves the productivity of a women's activity will make her or her children better off. According to Udry, in inefficient households, women achieve much lower yields and profits on land similar to that of their husbands, in Ghana however it is about local politics and even profitable technology may not be adopted if resources cannot be allocated efficiently in the household and if market inefficiencies (like land tenure) enter into the household. Udry noted further that efficiency does not necessarily mean gender equality, although the efficient households are more likely to use new technology productively.

Cost Benefit Analysis

Lisa Ortiz (USAID)

Lisa Ortiz presented on Cost-Benefit Analysis, specifically the logic and process behind ERRs. In evaluating the investment-worthiness of projects, Ortiz explained the process of calculating an economic rate of return (ERR) using cost-benefit analysis (CBA). Ortiz compared net present value (NPV) and cost-benefit analysis (CBA) to show the benefits of CBA. To calculate the NPV you must pick a discount rate Ortiz noted, and CBA solves for the discount rate. Ortiz explained that the benefits of CBA are: it includes non-monetary costs (like opportunity cost of time), it helps identify issues for evaluation and study, it provides targets against which to measure success, it is the way many development agencies do business, and lastly, cost benefit analysis highlights critical assumptions which allows testing the sensitivity around them. Ortiz also mentioned the downsides: studies show that estimated ERRs are consistently biased upward – what is needed is a system of checks and balances, and an expanding evidence base – a higher ERR doesn‘t mean a higher absolute return, and project investments can be lumpy so it is not always easy to move resources from one to the other quickly even if you discover that one has a much higher ERR.

Investments in Technology within the Global Hunger and Food Security Initiative

Rob Bertram (USAID)

Working Group 3: How Should USAID Integrate Technology into the Feed-the-Future Initiative?

In this working group, participants discussed the challenges faced by USAID missions and best practices in identifying promising technologies, and reviewed strategies for adoption and how to integrate them into evidence-based programming.

The *Agricultural Technology Adoption and Food Securityin Africa Evidence Summit Brief* prepared by

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DISCLAIMER

Agricultural Technology Adoption & Food Security in Africa
Evidence Summit Agenda (Detailed Draft)
Westin City Center Hotel
National Ballroom – Section A
June 1-2, 2011 – Washington, DC

Purple = Confirmed speaker

Time	Speakers	Topic
JUNE 1ST* DAY 1		
8:00 – 8:30 am	Registration	
9:00 – 9:25 am	Opening Remarks	**Winston Allen, Introduction** **Cynthia Clapp-Wincek, USAID/PPL** **Julie Howard, Deputy Coordinator for Development, Feed the Future**
9:25 – 9:30 am	Ed, Winston, Temina	**Snapshot of Agenda, Q&A**
9:30 – 10:00 am *Q&A: 10 min*	**Derek Byerlee** (SPIA)	**LECTURE: Technology and agricultural production in Africa** *Overview of the relationship between technology and agricultural productivity, highlighting technologies with potential for socio-economic transformation of the agricultural sector in Africa.*
10:00 – 10:45 am *Q&A: 5 min*	**Chris Udry** (Yale)	**LECTURE: Barriers and constraints to agriculture technology adoption in Africa** *Revisit the question, "Why has agricultural technology adoption and diffusion in Africa lagged behind that of other areas in the developing world?" Presenters will propose a new path for accelerating adoption and diffusion of technologies.*
10:45 – 11:00 am	BREAK	
11:00 – 12:20 pm *Chair – 15 min* *3 Panelists (15')* *Q&A: 20 min*	**Michael Kremer**, Chair& Moderator	**PANEL: Profitable Agricultural Technologies: Evidence from the field** *Panel presentation and discussion of selected technologies with demonstrated impact on increased productivity and income among African farmers.* Topics: **Marianne Banziger** (CIMMYT) — How uptake was achieved, at scale, for drought resistant-maize (Angola, Mozambique, etc) **Shawn Cole** (HBS) — Innovative financial products and services (indexed insurance) **Dan Gilligan** (IFPRI) — Measuring the nutritional impacts of biofortified sweet potato in Mozambique and Uganda
12:20 – 1:20 pm	LUNCH	

Time	Speakers	Topic
1:20 – 2:30 pm *Chair – 15 min* *3 Panelists (10')* *Groups – 10 min* *Q&A – 15 min*	**Rachel Glennerster** (J-PAL), Chair & Moderator	**PANEL: Promising agricultural technologies: What evidence do we need on the profitability of new technologies?** *Panel presentation and discussion addressing how we can generate more evidence on profitability of new technologies. What evidence do we need for decision-making? How does heterogeneity of local agro-ecologies get incorporated into decision-making?* Topics: **Bekele Shiferaw** CGIAR — Research centers' perspective **Florence Kondylis** (World Bank) — AADAPT **Jeffrey Ried**(Gates) — donor perspective Input during discussion from: Dr. Adewale Adekunle (Director of Partnerships and Strategic Alliances, FARA)
2:30 – 2:45 pm	BREAK	
2:45 – 3:35 pm *Chair – 15 min* *2 Panelists (10')* *Groups – 5 min* *Q&A – 10 min*	**Nava Ashraf**(HBS), Chair& Moderator	**PANEL: Gender and agricultural technology adoption** *Focus on the role of women within African agricultural systems and discuss the role of gender in technology adoption and diffusion.* Topics: **Barbara Bamanya** (AGRA) — Access to information and inputs **Emily Hogue** (BFS) — Tool for measuring women's empowerment **Cheryl Doss** (Yale) — Land rights, access to assets
3:35 – 4:40 pm *Chair – 15 min* *3 Panelists (10')* *Q&A: 20 min*	**Wendy Abt**, Chair& Moderator	**PANEL: Strategies for increasing adoption of profitable agricultural technology: Risks, Savings and Finance** *Discuss evidence on the role of financial services access in technology adoption and diffusion.* Topics: **Michael Carter** (UC Davis) — Insurance-credit contracts and savings-voucher coupons **Xavier Gine**(World Bank) — Rainfall-indexed insurance (India), savings in rural Malawi, credit cooperatives **Michael Kremer**(Harvard) — Collateralized loans
4:40 – 5:30 pm	GROUP WORK	**Working Groups:** ▪ Discuss new/ongoing programs of USAID mission staff and other practitioners in the group (Pre-task participants to come up with materials for this work). ▪ What evidence do you have for profitability of this technology in your target population? Does today's discussion challenge your evidence? What strategies are you currently using to promote adoption? ▪ Identify technology adoption (or profitability) challenges in the field, including key questions that need to be answered.
JUNE 2ND * DAY 2		
8:30 – 9:00 am	BREAK-FAST	

Time	Speakers	Topic
9:00 – 9:30 am	REPORT BACK	**Discussion:** ▪ Report-Outs from Working Groups (Day 1) ▪ Overview of Agenda for Day 2
9:30 – 10:45 am *Chair – 15 min* *4 Panelists (10')* *Q&A: 20 min*	**Mywish Maredia** (MSU) Chair & Moderator	**PANEL: Strategies for increasing adoption of profitable agricultural technology: <u>Role of policies, institutions, social networks, and supply chains</u>** *Discuss evidence of various policy, institutional, and community-based strategies for increasing the rate of technology adoption and diffusion in Africa. Evidence will be drawn from public and private sectors.* <u>Topics</u>: **Norman Uphoff** (Cornell) — Experience with multi-sectoral strategies for disseminating a proven agricultural technology **Ruth Vargas Hill** — Informal risk-sharing groups and rainfall insurance **Duke Burruss** (DAI) — Market development, supply chains, private sector linkages
10:45 – 11:15 am	BREAK	
11:15 – 12:15 pm *Chair – 15 min* *2 Panelists (15')* *Groups – 10 min* *Q&A – 20 min*	**Paul Hixson** (UI), Chair& Moderator	**PANEL: Strategies for increasing adoption of profitable agricultural technology: <u>Extension, Training and Information Innovations</u>** *Role of public and private sectors in extension, and the potential of modern approaches to promoting new technologies will be discussed during this session.* <u>Topics</u>: **Burt Swanson** (ATMA) — Modernizing extension **Paul Roberts** (ForgetMeNot) — Information and communication technologies **Jeremy Magruder**(UCB) — Extension experiment (information diffusion)
12:15 – 1:15 pm	LUNCH	
1:15 – 2:00 pm	GROUP WORK	**Working Groups**: Review and discuss the Technology Assessments Tool: Ask groups to provide feedback using flip-charts Q&A: Is the tool useful? How might you use it? Does it deal adequately with local context & agro-ecology?
2:00 – 3:10 pm *Chair – 15 min* *3 Panelists (10')* *Groups – 10 min* *Q&A – 15 min*	**Markus Goldstein** (World Bank), Chair& Moderator	**PANEL: Strategies for increasing adoption of profitable agricultural technology: <u>Interventions for Women and Girls</u>** *Discuss evidence on the strategies to enhance women's technology adoption and access to information.* <u>Topics</u>: **Chris Udry** (Yale) — High value crops **Roger Salway** — Compatible Technology International
3:10 – 3:30 pm	BREAK	**Demo –** Compatible Technology International
3:30 – 3:45 pm	**Lisa Ortiz** (USAID)	**LECTURE: Cost Benefit Analysis**
3:45 – 4:00 pm	**Rob Bertram** (USAID)	**LECTURE: Investments in Technology within the Global Hunger and Food Security Initiative**

Time	Speakers	Topic
4:00 – 5:00 pm	GROUPS**	**Working Groups: How should USAID integrate technology into Feed-the-Future Initiative?** *Break-out groups discuss challenges identified earlier by USAID missions and other practitioners. How to identifyor demonstrate profitability of technologies?Review strategies for adoption discussed in earlier working group;how to integrate or generate evidence? Discussions captured by a rapporteur for each group. Output = proposals to inform mission agriculture strategies based on what is demonstrated by the evidence.*
5:00 – 5:20 pm	REPORT BACK	**Rapporteurs (3 min each)**
5:20 – 5:30 pm	CLOSING	

**Framework for Working Groups

We anticipate no more than 8 people per working group, including USAID Mission staff as well as academic and practitioner panelists. If there are 64 people attending the event, this will translate into 8 groups of 8 people each. Working groups will be conducted around round tables in the main conference hall.

Framework for Panels

Prior to the Summit, we will organize a panelists' phone call for each panel, to discuss the topic. Note that each panel below will have the following framework:

- Chair – 15 min Overview of the topic
- Panelists – 5 slides, 10 minutes each
- Q&A: Either take questions directly from the audience, or split into small groups for 5 minutes to develop 1-2 priority questions to ask of the panelists

Summit Deliverables

- Booklet of studies discussed (1-pagers outlining evidence)
- Booklet of powerpoints from USAID program staff & NGO presenters
- Package of speaker presentations (online screen-cast)
- Proposals generated by working groups
- Tool for agricultural technology assessments (draft provided for feedback)

All NGO participants will be invited to bring materials for a display table outside the conference hall.

Agricultural Technology Assessment Tool

In assessing the utility and appropriateness of an agricultural technology for farmers and other actors in the value chain, it is important to consider multiple interlinked factors. These include the potential for risk exposure, the availability of complementary inputs, and the reliability of delivery institutions. The decision to introduce or promote a new technology should weigh the potential pitfalls—such as increased risk to farmers, or environmental degradation—alongside the magnitude of potential benefits. It is also essential to evaluate the quality of the evidence on costs and benefits (i.e. the certainty with which pitfalls or positive impacts can be estimated or predicted). Note that we define technology broadly to include improved agricultural practices, crop varieties, inputs and associated products such as crop insurance.

This tool is designed for use as a framework for assessing the potential scalability of an agricultural technology and to facilitate decision-making discussions by NGOs, donors, governments, technology developers and other stakeholders. The tool is broken into three sections:

- Section one helps identify the problem that the technology seeks to address and to identify alternative solutions.
- Section two offers a rubric for estimating the magnitude and certainty of a technology's benefits to small-holder farmers, their communities, and to other actors in the agricultural value chain.
- Section three provides a framework of potential pitfalls to consider. Each type of potential pitfall is accompanied by a series of questions intended to stimulate discussion. Not all questions are relevant to all settings, and many relevant questions are omitted, so those included should be used to start the conversation, not as an exhaustive list.

In using this tool, you should be able to roughly estimate the probability of appropriate technology adoption and the scalability of the technology, given existing knowledge of potential benefits and failures. "Appropriate technology adoption" is defined to mean the take-up and use of a technology in a way that proves utility-enhancing, profitable, and/or welfare-increasing for farmers and others along the agriculture value chain.

A. Problem Identification

What problem is the technology intended to address? On what evidence is the definition of the problem based? What are alternative or competing technologies (or non-technological approaches) for addressing this problem? Where did the idea for the proposed technology come from? What evidence is there on what has worked/failed in for addressing similar problems?

B. Magnitude & Certainty of Benefits

What is the magnitude of the technology's benefits for small-holder farmers?
The benefits for each technology will be different—a technology might reduce yield variability, increase yields, reduce labor costs, etc. There are trade-offs between benefits and costs, but let's begin by identifying and listing the types of benefits and their magnitudes. Describe and discuss, then use the table below to select the overall magnitude of the benefit you expect: Low, Medium, or High.

How certain is the estimate of magnitude? Is there high quality evidence to support that prediction?
Consider whether this technology is new or has been adopted elsewhere. If the latter, have rigorous impact assessments been carried out to measure not only changes in yield/output, but also changes in household welfare (e.g. nutrition or consumption)? How extensively has the technology been adopted elsewhere—what is the take-up rate? Who are the main adopters in these settings? How do these settings differ from the proposed context? Describe and discuss, then use the table below to select how certain the benefits are: Low, Medium or High.

		Magnitude of the potential benefits		
		Low	**Medium**	**High**
Certainty about the magnitude	**Low**			
	Medium			
	High			

C. Pitfalls of Scaling Up

Below is a listing of potential barriers to the appropriate (i.e. profitable or utility enhancing) adoption of a new technology. For the technology under consideration, please explain how appropriate adoption might be affected by each of the barriers listed below. How problematic is each barrier likely to be in the proposed context (~~m~~agnitude" of problem)? Is there any evidence to support this prediction (~~c~~ertainty" of failure)?

For each potential pitfall, describe and discuss how it applies to the setting and technology under consideration.

1. Does this technology increase the amount of risk that farmers or other actors in the agricultural value chain face?

Are yields, sales or profits highly variable? Is the risk known and understood by users of the technology? Are benefits from the technology dependent on unreliable or uncertain access to other inputs or complementary technologies? Will profits become more dependent on output prices?

2. Does this technology require any other inputs, systems, institutions or supporting markets?

Are credit, insurance or other financial services required? Does it require complementary inputs like irrigation or fertilizer? Are seed sources or other supply chains reliable? Does it require post-harvest processing, additional labor, or linkage to new markets? Is the technology distributed by agricultural extension workers? Is contract enforcement or other supporting legal or political institutions required for scale-up?

3. Does the use of this technology require any information or training?

Will diffusion and scale-up of the technology require knowledgeable trainers or marketers? If this is a new technology, how is information made available? Is there a need for training for users? Who will need to maintain or fix the technology? Do men and women have equal access to information about the technology?

4. Are there social or cultural constraints to adoption of this technology, or its product?

Is there low willingness to pay for the technology or its outcomes? Are there cultural preferences (i.e. food flavor or appearance) that could cause failure to adopt? Is there community sanctioning of certain activities associated with the technology or its adoption (e.g. gender constraints)? Are there local traditions that might inhibit adoption? Are there power dynamics within the household or community that would affect adoption?

5. Are profits, benefits or yields shared among many people?

Do some benefits (or costs) accrue beyond the direct user? Do some benefits (or costs) accrue to society at large? Do benefits (or costs) accrue preferentially for women or men?

6. Are yields and profits distributed across time?

Are some benefits delayed into the future? Do additional costs come before benefits are realized? If so, is the technology accompanied by sufficient short run incentives to encourage adoption? Will the technology deliver profits in the short and long term?

7. Will geographical constraints or a need for targeting make distribution difficult?

Are communities too sparsely settled for efficient distribution of the technology (or associated marketing information)? Will the product require targeting to certain groups? Is it only appropriate for some types of users, and not others? Is there demand from only certain types of users, such as farmers with very small or very large landholdings?

8. Does the purchase or use of this technology have any negative spillover effects?
Does the technology cause environmental degradation? Does it displace other important [economic or household] activities? Does it displace other purchases? Will introduction of the technology cause rapid changes in other market prices? Are there negative health consequences?

9. Are local microclimates or agro-ecological zones appropriate for this innovation?
Is the technology designed or adapted for different rainfall patterns or soil types? Is it vulnerable to local pests and diseases? Is high quality evidence available on the agro-ecological appropriateness of the technology? How adaptable is the technology to variations in microclimates?

10. Does this technology require cooperation among groups of farmers or households?
Does the technology generate unequal benefits among group-members? If a cooperative or other collective institution is required, is there risk that resources or decision-making will be "captured" by community elites? Is there a risk that some group-members will "free ride"?

11. Is this technology sustainable?
What is the long term growth opportunity? Does this technology help a dying market or a declining crop? Is the technology accessible/affordable for farmers? Does the technology require long term support from the public sector (NGOs, donors, governments)?

Agricultural Technology Assessment Tool (Example)

Example 1: Fertilizer trees (*faidherbia albida*) in Central Malawi
Basic objective: Increase adoption of nitrogen fixing trees for interplanting with crops

Note: This is only an example, not intended to serve as a real evaluation of the potential for fertilizer tree scale up in Central Malawi.

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How certain is the estimate of magnitude? Is there high quality evidence to support that prediction?
Consider whether this technology is new or has been adopted elsewhere. If the latter, have rigorous impact assessments been carried out to measure not only changes in yield/output, but also changes in household welfare (e.g. nutrition or consumption)? How extensively has the technology been adopted elsewhere—what is the take-up rate? Who are the main adopters in these settings? How do these settings differ from the proposed context? Describe and discuss, then use the table below to select how certain the benefits are: Low, Medium or High.

Example: A fair amount is known about the technology based on field trials conducted by CG centers and by agricultural research stations. These trials suggest high fertility benefits. However, these trials tend to ignore inputs, such as labor, and also the variability of benefits coming from the fertilizer trees. Consequently, the certainty around the true benefits that accrue to the farmer still require rigorous evidence. The certainty of the magnitude of potential benefits is probably ~~"m~~medium".

		Magnitude of the potential benefits		
		Low	**Medium**	**High**
Certainty about the magnitude	**Low**			
	Medium			
	High			

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For each potential pitfall, describe and discuss how it applies to the setting and technology under consideration.

1. Does this technology increase the amount of risk that farmers or other actors in the agricultural value chain face?

In the short run, trees will be vulnerable to many threats, including drought, fire and pests. While in the long run, the trees may help lower risk by providing a reliable source of nitrogen for crops even when chemical fertilizer is not available, the returns on investment for the farmer are quite risky.

2. Does this technology require any other inputs, systems, institutions or supporting markets?

The main input is labor, and in dry years, the amount of watering needed may be high. If the farmers are being asked to establish nurseries, they will need materials for seedling germination and for the physical nursery. The main complementary input that is needed is training (see #3).

Fertilizer trees rely on a number of supporting institutions and markets. First, agricultural extension workers will be relied upon for ongoing technical assistance. Past experience suggests high turnover of these staff that may complicate reliable support from them.

Second, seed supplies have faced shortages in the past. Reliance on existing suppliers will be inadequate if demand takes off. Local supplies will be developed as part of the scale up effort, with community-level training for nursery establishment. However, these local supplies are relatively untested and may be a major vulnerability.

3. Does the use of this technology require any information or training?

Correct planting and care does require training of farmers. Once trees are established, further technical inputs should not be required. Seed germination requires additional training and possible ongoing technical assistance.

4. Are there social or cultural constraints to adoption of this technology, or its product?

Subsidized chemical fertilizer is distributed annually in the target scale up area. This may lower willingness to pay for fertilizer substitutes (fertilizer trees). The trees do not affect food or other agricultural production beyond (hopefully!) impacts on future yields. They are unlikely to face cultural constraints.

5. Are profits, benefits or yields shared among many people?

The shared benefits of the technology come mainly from the nursery. Community members who do not assist with the nursery construction and seedling germination may still be able to access and benefit from the seedlings.

Some of the benefits of the trees benefit to others in the form of less fertilizer run off during the rains. Benefits from the trees are not particularly gender-biased, though women may benefit from less weeding once the trees are mature (they drop their leaves at the first rain, forming a ground cover that suppresses weed growth).

6. Are yields and profits distributed across time?

Benefits do not accrue until ~3 years after planting. This is longer than most agricultural investments in the area. The costs come in the first year. This is likely to be a major challenge for scale up.

7. Will geographical constraints or a need for targeting make distribution difficult?

The technology is appropriate for the vast majority of farmers in the target area. Distance to the nearest nursery may increase the costs for some farmers.

8. Does the purchase or use of this technology have any negative spillover effects?

No, in fact, it has positive spillovers by lowering soil depletion from chemical fertilizers and lessening dependence on the fertilizer subsidy program.

9. Are local microclimates or agro-ecological zones appropriate for this innovation?

The trees will grow best in damp soils near streams. They will be vulnerable to pests and drought when they are young. With watering and proper care, they will grow in most soils in the scale up area.

10. Does this technology require cooperation among groups of farmers or households?

The nurseries do require cooperation, and may benefit some more than others. Someone has to provide land for the nursery construction (unless communal land is available). Some community members may strategically wait until the seedlings are ready for planting before joining in. Attempts to prevent free riding might generate some community conflict. On the other hand, the nursery is unlikely to involve much in the way of cash transactions, so risks may be lower.

11. Is this technology sustainable?

What is the long term growth opportunity? Does this technology help a dying market or a declining crop? Is the technology accessible/affordable for farmers? Does the technology require long term support from the public sector (NGOs, donors, governments)?

The technology may face some sustainability challenges given the limited private sector opportunities, given that farmers make a one-time investment (purchase seedlings) that provides little profit margin for suppliers. Development of community nurseries is intended to address this sustainability concern. The technology is a partial substitute for chemical fertilizer, so depending on long-run oil prices, demand for fertilizer trees may have a very bright future!