REPORT ON THE WORLDAGINFO VISIT TO SOUTH ASIA (INDIA AND SRI LANKA) [1]

June 2 - 16, 2007

I. Introduction – The WorldAgInfo Project

Cornell University, with funding from the Bill and Melinda Gates foundation, is hosting a Design Team, which is charged with assessing agriculture information, education and knowledge systems in South Asia and Africa in order to provide a landscape view of information needs of smallholders and identify possible proposals to the foundation that address the ICT technology needs of smallholder farmers at the "first kilometer level." This landscape analysis also focuses on the needs of others, such as agricultural researchers, educators and students, in the agricultural education/information chain. The foundation is currently preparing its new agricultural strategy with the input and involvement of stakeholders at the grass-roots level. As a part of this participatory and "bottom-up" approach, the foundation has charged the Design Team to consult, interact and seek input from smallholder farmers and public and private institutions supporting smallholders in South Asia and Africa. This consultation process includes site visits to South Asia in June and Africa in August of 2007 followed by two workshops focusing on the content and delivery systems and a combination of conventional approaches and modern ICT technologies.

The four objectives of the projects are the following:

1. Identify agricultural information needs of key stakeholders all along the education/information chain. (e.g., smallholder farmers, researchers, policy-makers, agriculture university faculties and students, extension personnel, private sector, and public media representatives.)

2. Identify promising new information technologies that can be leveraged into activities to improve the livelihood of smallholder farmers.

3. Explore the feasibility of using collaborative community-based knowledge mechanisms to increase access to agricultural information and to provide the feedback mechanisms necessary to assess the relative values of that information.

4. Explore the socioeconomic context of smallholders with special attention to ways to empower women as contributors and end users of collaborative agricultural information systems.

[1] This summary report includes inputs from the following members of the Design Team: Karim Maredia, Carl Eicher, Dwight Allen, Mary Ochs, and Thane Terrill in collaboration with Cholani Weebadde.

This report provides a summary of the meetings and discussions in India and Sri Lanka with various stakeholders and institutions, key observations, and preliminary recommendations based on the interactions and input from the stakeholders.

II. Consultation with Stakeholders

Five members of the Design Team visited India and Sri Lanka from June 2-16, 2007 to interact with various stakeholders. We visited with more than 500 farmers, local market workers, extension workers, bank officers, representatives of the private sector, researchers and with the staff of three universities and their associated libraries.

India and Sri Lanka differ greatly in size and historical experiences; they provided our trip with a useful contrast in terms of institutional structure and educational systems that support smallholder farmers.

The main goal of the site visits was to gain first-hand experience about the problems and information needs of smallholder farmers and the role that institutional innovations and ICT can play in fulfilling the four objectives just listed.

One of many group meetings with farmers

Site visit to India: India is a vast country with more than 600,000 villages and home to one billion people and 100,000 extension workers. More than two thirds of the population depends on agriculture for their livelihood. More than 70% of the farmers in India are smallholders, defined as a farmer with less than a hectare of land holdings. The farmers are the consumers of the majority of the farm produce and the surplus is sold in local markets. The literacy rate in India is around 60%.

In India, agriculture is a state subject primarily supported by the state governments with additional funding coming from the central government and other sources. Each of the states in India has at least one State Agricultural University (SAU). These universities are similar to American agricultural universities that were created by the U.S. Land Grant System. The SAUs have a mandate for research, teaching and a shared mandate for extension with the State Department of Agriculture and the Central government. The front line extension workers are employed by the State Department of Agriculture while SAUs provide extension specialists and technical support to field programs.

The Indian Council of Agricultural Research (ICAR) operates and supports more than 80 agricultural research institutes across India that focus on specific crops and agricultural constraints. In addition, ICAR provides financial support to more than 500 Krishi Vigyan Kendras (KVKs or Agriculture Science Centers) that are located in every district of India. The

KVKs play a role in training, demonstration and outreach activities. Recognizing the need to foster interactions among various stakeholders, the Government of India has established a group of agencies called Agricultural Technology Management Agencies (ATMA).

Considering the diversity of agroecosystems and cultures, the two states, Haryana in northern India and Kerala in southern India were selected for site visits and interactions with the smallholders and institutions that support them. The neighboring states of Haryana and Punjab are considered to be the "bread basket of India," producing more than 40% of the national staple food grains (wheat and rice). The state of Kerala, on the other hand, is known for plantation crops (coconut, rubber, and spices), fruit crops and rice-based diverse cropping systems. The Design Team visits to Haryana and Kerala were organized by the CCS Haryana Agricultural University in Hisar and the Kerala Agricultural University in Trichur, respectively. The visits to these two states were complemented by consultation with various stakeholders through a roundtable forum organized by The Energy and Resources Institute (TERI) in New Delhi, visits to the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), National Institute of Agricultural Extension Management (MANAGE), and E-Sagu and Digital Green—a video-based agriculture training and information system.

Site visit to Sri Lanka: Compared to India, Sri Lanka is a small country with around 12,000 villages and a total population of about 20 million people. Sri Lanka is one of the top twenty-five richest countries in terms of biodiversity. The literacy rate in Sri Lanka is 93%, one of the highest in the developing world. The majority of the farmers in Sri Lanka are smallholder farmers with less than one hectare of land.

Sri Lanka's attainment of almost complete self-sufficiency in rice production has been a major achievement over the past 40 years. However, agricultural growth has fallen to 1.5% per annum. The government's priority is to enhance the rice production from around 3.5 to 5 tons per hectare. A 2007 World Bank Study[2], calls for a shift from being supply-driven (producer of rice) to producing more high-value crops, livestock and related products.

The Design Team visited smallholders in the Dambulla area in the North Central Province of the country. With the support of the Cargills (Ceylon) Ltd Company, the Design Team met with smallholders from 19 districts across the country and discussed their sources of information and future research and extension priorities. The interactions with the smallholders were complemented by a roundtable discussion with stakeholders in Colombo and visits to the Department of Agriculture, IWMI (International Water Management Institute), RRDI (the Rice Research and Development Institute, Department of Agriculture, Sri Lanka), and with the University of Peradeniya which has the only post graduate institute of agriculture in the country.

III. Key Agriculture-related Observations from India and Sri Lanka

1. **Overview of concerns and opportunities with agriculture in South Asia**:
    A. **Concerns**:
        a. Smallholder poverty

[2] "Reviving Sri Lanka's Agricultural Research and Extension System: Toward more innovation and market orientation"

b. Declining yields of food staples
c. Rising rural wages
d. Declining water tables
e. Negative impacts of farm subsidies.
f. Declining performance of key agricultural support services
g. Lack of smallholder access and information on credit and insurance
h. Prospects of negative impacts of climate change

B. Opportunities:

a. Improving access to technology and technical training
b. Provide greater access to trusted, timely information
c. Expand cell phone coverage by smallholders
d. Better access to market prices and the requirements of products destined for the international market
e. Expand private sector participation in providing market information and infrastructure
f. The growth of community lending groups and farmer cooperatives
g. New government regulations that extend loans for agricultural purposes

2. Smallholder Farmers Objectives: Based on discussions with smallholder farmers in India and Sri Lanka, the team observed that the smallholder farmers were eager to gain access to information related to new crops, up-dated farming practices, affordable credit, new technologies, market pricing and to the standards required for selling products on the international market. The central factor was accurate and timely information. Farmer might have the ability to purchase or lease additional land but they cannot afford to make a commitment without having accurate information regarding market prices, cost of production and new rules that may assist or hurt the anticipated use of that new land. The farmers frequently asked for information on how to obtain the information that would allow them to make economic decisions.

One of the most exciting and promising findings is that the smallholder farmers, in at least the relatively remote areas we visited, are eager to access and use new communications technology, particularly where the younger generation has access to upper-secondary school education.

3. Decline in Agricultural Productivity: The very success of the Green Revolution of the 1970s and 1980s has produced a period of complacency and policy indifference to agriculture over the past 15 years. This might be acceptable if the techniques and strategies of the Green Revolution continued to work successfully, but the reality is that agricultural productivity is declining in most regions of South Asia with further prospects of even greater loss of productivity due to a combination of water scarcity and deteriorating soil health. The people we met well understood these two major impacts and the disastrous consequences of the current trend in declining productivity. Making the situation even more challenging is the unpredictable influence of global weather changes. It is one thing to respond to a challenging situation from a condition of health and yet another thing to respond while ill. It is clear from our visit that timely and accurate information will be vital to responding to this rapidly evolving set of agricultural challenges.

Haryana field with water conserving beans

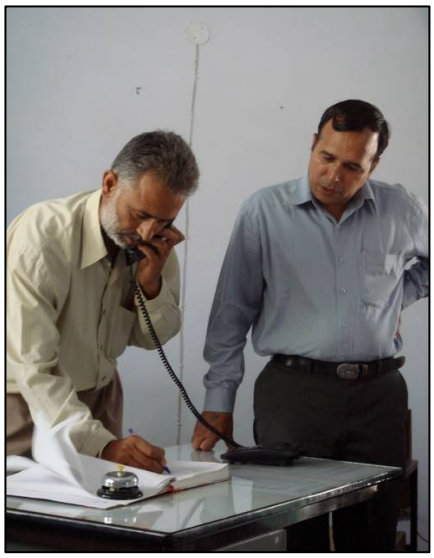
4. Agricultural Support Services: Education, Research and Extension

a. Agricultural Education: The 41 State Agricultural Universities (SAUs) in India and the agricultural faculties in Sri Lanka are under funded and under staffed. In 2005, about 30% of the academic positions in the SAU systems in India were vacant (Patil et al. 2006). This hiring restriction severely limits the ability of the SAU's to initiate badly needed new postgraduate programs in food science, biotechnology, food processing and agribusiness. Similar trends related to declining budgets and their impacts on the quality of higher education were observed in Sri Lanka. At a time where flexibility and mobility are essential for responding to rapidly evolving agricultural challenges, we found the agricultural institutions to be flat footed.

At the undergraduate level, the disconnect between the current agricultural curriculum and the manpower needs of the society was underlined in conversations with students and faculty who agreed that a large majority of agriculture graduates don't pursue an agriculture related job. We were informed by agriculture students that agriculture universities are commonly viewed in India as "also ran" places for prospective students not admitted to "more desirable" schools. In one our meetings, with a group of thirty students, only a handful saw themselves working in agriculture after their graduations.

b. Agricultural Research: Our group observed that in many cases, research findings are known at the university/research level but that this information was not effectively conveyed to the smallholder farmer. There is also a surprising lack of the sharing of information between research entities in different Indian states. Clearly the means to communicate between institutions should be improved so that solutions to common problems may be shared.

c. Agricultural Extension/Outreach: Our group observed that the current extension systems in India and Sri Lanka are weak and not very effective in delivering real-time information to smallholder farmers. We asked farmers during our group meetings to identify their main sources of agricultural information. The answers we receive depended on the type of information being sought. Weather and general information was looked for on television and radio. Newspapers carry general information and may also include a section covering the type of questions local farmers are having and the answers to those questions. Farmers expressed concern that the information sources often didn't agree and they lacked the ability to determine which source was timelier or trustworthy.



HAU's agricultural call center

When it came to more specific information, the farmers had a much more difficult time finding the information they desired. At the Haryana Agriculture University (HAU) we saw one of the new Kissan Call Centers. These call centers have been established in each state in India to provide individualized answers. For example, how much fertilizer to apply or what to do when plants turn an unusual color. We initially assumed that the farmers we met did not know about this new service given that there were expressing frustrations at not having the type of information that we knew the call centers claimed to supplied. What we heard from the farmers was that they did know about the call centers and that they had the access to village pay phones and to cell phones. The problem was that they could not get through to the call centers.

During our visit to HAU's call center, we discovered the reason why farmers could not get through: the call center had one telephone. That single telephone was designated to support Haryana's 1.7 million farmers. HAU knew that this coverage was not adequate but did not have the financial resources required to operate more lines. Our meetings with farmers indicated that they would be willing to pay for the call if they could get the information they needed. On more than one occasion the farmers said they would be willing to buy a cell phone if it could be used to access important agricultural information.

Community radio is a promising concept, but in India there are regulatory issues blocking community radio. Our discussions indicated that India might be at a point of possible reconsideration of these restrictions. It is also possible that podcasting and other more directed forms of mass communications could an alternative route to providing the benefits of community radio.

5. Markets and Food Systems: The roundtables on agriculture marketing systems noted the expansion of supermarkets and the benefits the private sector could bring to smallholder farmers. The team was impressed with the innovations of the Vegetable and Fruit Promotion Council in Kerala (VFPCK), a collaborative that has helped develop a network of smallholders in fruit and vegetables production, marketing and microfinance. These farmer innovations are helping to address the inequities of pricing by middleman who have the best access to market information. In many cases, the farmers said they had no idea of the market prices in other towns or what the

middleman received for their sales. The middleman was by far the most disliked and least trusted component of the supply chain.

Cargills (Ceylon), a large supermarket chain of 117 stores through out Sri Lanka uses a combination of superior market information and direct purchasing from the farmer to provide a 20% premium on the sale price for farmers and assure the best value for its consumers. We were impressed with Cargills' agricultural extension program. The farmers we met were very pleased with the information Cargills' employees supplied them on agricultural practices. The only significant problem the farmers reported was their inability to sell their entire range of products to Cargills.

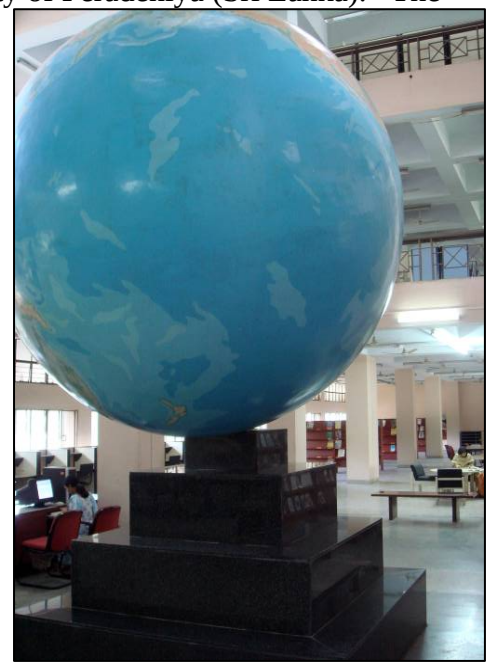
Typical Kerala wholesale market

In both cases, the value of cooperatives and supermarket out-reach programs can extend beyond the community of participating farmers. Farmers are quite collaborative by nature. Many times our group found that farmers referred to other farmers as the main source of trusted information. When new information sources permeate the community as a whole they put pressure on middlemen to offer fair prices.

6. Post-harvest Losses of Fresh Produce: One third of the fruits and vegetables produced in India and Sri Lanka are lost to spoilage or the inability to sell them after harvesting. In Sri Lanka we met one man who purchased leftover produce for his pig farm. He paid virtually nothing for the day old produce simply because the farmers did not have access to a refrigerated facility. The lack of market information and inflexible transportation options means that farmers have no option other than to bring produce to the market with hope that all will be sold that day. The Design Team was frequently asked about new international markets as an opportunity to absorb the local peaks in production that frequently now go to waste.

7. Credit/Microfinance: In the absence of effective microfinance organizations, the smallholder farmers are in the clutches of private money lenders who are charging interest rates ranging from 60 to 120% per year (as compared with 7-12% from local cooperative and commercial banks). Because rural wage rates are rising, farmers are keen on purchasing farm machinery to replace hired labor. While India law has created a number of loan programs for the benefit of the smallholder farmers the Design Team found that farmers were either unable to qualify for these loans or were asked for collateral in situations where the law indicated that none should be required. We were left wondering if the bankers were unaware that farmers were not finding the loans to be as expected or whether the farmers we spoke to misunderstood the loan parameters and were thus disappointed. This situation seems to be one where even a little more information and feedback on the part of bankers and farmers might have a huge impact.

8. Libraries: The Design Team visited three university libraries: Haryana Agricultural University, Kerala Agricultural University and the University of Peradeniya (Sri Lanka). The team also met with librarians at MANAGE, ICRISAT in Hyderabad, and IWMI in Colombo, Sri Lanka.



Kerala Agriculture University library

The librarians at all three university libraries we visited were knowledgeable about new ICT technologies and their applications for libraries. However, to varying degrees, the librarians were frustrated by serious funding issues, which prevented them from effectively serving the university's students and staff. The key issues identified by the librarians included: staff shortages, poor Internet connectivity, old and/or inadequate numbers of computers, cuts in journal subscriptions budgets, and seriously outdated collections.

We found the librarians we met to be creative and energetic at providing the best service possible within the tight constrains they experienced. For example, their libraries participate in various networks for document delivery and have developed exchange agreements with other institutions to obtain publications. Several libraries have set-up "book banks" for students to borrow textbooks, and they are launching projects to digitize theses and dissertations. Given the serious shortages of books and journals, the digitization of agricultural information and subsequent access to it via the Internet or DVD readers appears to be one of the most practical means by which these libraries can be brought up to international standards.

The national organization libraries, such as MANAGE and CGIAR (e.g., ICRISAT and IWMI), are considerably better off in terms of funding, infrastructure and facilities. They offer tailored collections of books, journals and online resources for staff members of their organizations, and they participate in outreach activities, such as training and digitizing projects. The staff at these libraries may well be ideally suited to assist with the needed modernization projects we found to be required at the university libraries.

9. Collaboration with CGIAR Centers: Our group visited the ICRISAT and IWMI centers and noted the pressures from donors to work on development projects rather than on their core research agenda. While ICRISAT and IWMI appeared to have improved funding, the reality is that an increasing share is earmarked for specific projects. The result is that the individual projects are well funded but core institutional services constantly have to adjust to limited financial resources. These are distractions that cannot continue if the CGIAR centers are to play an active role in assisting the universities.

10. Partnerships, Linkages, and Scientific Collaboration among Various Institutions in South Asia: Our group found that the linkages among various public research and academic institutions are weak in the South Asia region. These institutional linkages need to be enhanced and nurtured through a combination of technology projects and the sponsoring of regional conferences of topics of common interest.

11. Cell Phone and PC Access: While a large effort is being made to install PC-based kiosks, the potential near-term ICT success story in India and Sri Lanka is the use of cell phones by smallholder farmers. From our conversations with farmers, we estimated that in 20% of farmers in Haryana and 60% of farmers in Kerala has access to cell phones. Approximately 40% of farmers in Sri Lanka have cell phones. That number is rising rapidly. However, the farmers reported that they rarely use their cell phones for accessing agricultural information.

Farmers showing their cell phones

Our group noted that the personal computers have an important role to play in terms of information access at the university and KVK levels. However, there are many barriers to the wide spread use of computers by smallholder farmers including the substantial costs, irregular supply of power, lack of technical support and infrastructure, and lack of supporting business models. Even if personal computers and Internet access were practical, most farmers lack computer and literacy skills to make effective use of them. The computer-based ICT information systems are currently being built on shaky foundations. This will, of course, change as the infrastructure and literacy rates improve. There is no doubt that the PC with a fast connection to the Internet is the optimal platform for access to agricultural information.

IV. Key Information Technology Related Observations

1. Establishing Trust

Getting information to farmers, or anyone else, is futile if that information source is not trusted. Any system that is to serve the smallholder farmer must both function in their technical environments and instill the sense of trust. The technical issues, as difficult as they are, are trivial compared to the trust issue.

A PC in the field in India.

Perhaps the most consistent truth we observed related to the information needs of the smallholder farmer was the constant refrain that farmers respect the opinions of other farmers. Lack of trust in most sources of information was a consistent theme on our trip. Farmers don't trust middlemen, bankers, agriculture extension workers, and vendors (specifically in the sale of such basics as fertilizers, pesticides, and seeds). Given that all these elements of the agricultural environment will continue, the real question is how to make the information they provide trustworthy. We believe that the fact that farmer-to-farmer communications are trusted could supply a needed foundation of trusted feedback and evaluation that would either force the other entities to become more worthy of trust or their information would be deemed trustworthy -- when warranted.

Feedback, especially that which comes from farmers, supplies the only mechanism we could identify for assaying the value of the many information sources we explored. We visited research institutes, NGOs, and universities with various collections of research papers, reports, journals, and dissertations. Valuable information is certainly locked in these documents repositories. But determining what is a vein of valuable information and what are the less valuable surrounding materials is not easy task. The only solution we could identify is to openly and genuinely welcome all sources of information and to provide the feedback mechanisms that would allow for the proper classification of worth. The "many eyeballs" phenomenon of multiple user validation of information is one of the prime initiatives to pursue.

2. Breaking the Language Barrier

India reinforced our belief that some form of computer-assisted translation is necessary for any large-scale agriculture information system. Our investigations indicated that perhaps five or six of India's twenty-three official languages might be required to achieve even near universal information access.

We saw demonstrated a program that placed an English document in two panes side-by-side. The right-hand pane then started to be translated into Hindi. Those words that the system could not translate were kept in the original English. The human translator could select each unknown word and then put in the Hindi word. As each word is added, all future translations will benefit accordingly.

The key to this system's effectiveness is the language structure rules and the completeness of the dictionary. We were told that having approximately five thousand known good translations between a second language and English would provide the structural information required. The facility to translate words is directly related to the completeness of the second language/English dictionary being used by the computer.

Fortunately, there are bodies of documents in India that are in parallel languages. For Hindi, the primary source would be the Indian government because of their legal requirement to have documents in both languages. Of course, if a body of agriculture documents could be found in target languages, it would be even better. As for the dictionary, we were told during our visit to the Indian Institute of Technology in Mumbai that they were well on their way to creating an open source Hindi/English agriculture dictionary. We believe that the systematic translation of English language agriculture information into Hindi is well within sight and should be given serious consideration. We should also mention that many of the sources of local information we observed in the various agricultural universities we visited were primarily in English. These sources of information are potential goldmines of relevant local agricultural knowledge and their translation to other languages could make them more available to even the local populations served by the universities.

3. Rebuilding Agricultural Libraries

The majority of libraries we visited were under-funded and in need of updated resources. Creative solutions are needed for increasing library budgets for journal subscriptions and books while building new systems for improving access to open access documents. The libraries we visited all identified the Internet as a primary information source for their students. This claim was all the more remarkable when one saw that the library only had half a dozen old computers sharing an anemic Internet connection. If there is going to be a satisfactory solution to the deficits of the current agriculture libraries, it will be through the Internet and other online sources similar to the transformation taking place in American university libraries.

Clearly, the more agricultural information available to an online representation, the more feasible and valuable an online system would be for agriculture university libraries and for other conduits for agricultural information. India is one of the principle centers for document and book

scanning. Specifically, Carnegie Mellon University's Million Book Project has India as one of its main processing centers. Agriculture is one of the Million Book Project's core assets with partnerships with the UN's FAO, the United States National Agriculture Library, and U.S landgrant libraries, including Mann Library at Cornell . This collection, which has yet to be released, should be further augmented by the holdings of the local agriculture universities in India. Potential supplemental projects could include an Indian online agricultural journals portal, repositories for providing access to extension documents (one already in pilot stage at MANAGE), and a thesis scanning project (in pilot stage at Haryana Agricultural University). Every indication we saw is that such a comprehensive online collection would be extremely important to the agriculture universities and could potentially be transformational in its effects.

4. GPS and Satellite Imagery

Agriculture is unlike most other disciplines in that it is highly geo-specific. This is a very important fact to keep in mind as information becomes accessible on a global basis. What may work well in one location could be disastrous in another location. At IWMI (International Water Management Institute) we were told of their use of Google Earth's satellite images with local volunteers to take precise measurements of water use. The volunteers go out in the field to fixed GPS coordinates and report what they see. That information can then be used by the IWMI to calibrate its image processing system so that it makes accurate measurements from the images. IWMI is primarily interested in water management and they have already determined that reported water use is quite different from actual water use. These discrepancies are not surprising given that some forms of water use are fee based and thus under-reporting is in the farmer's interest. It would obviously be highly significant to know if the water table will be depleted in five years rather than in ten.

It would be very interesting to explore if this system now being used for water could be used for other agricultural measurements. The percentage of cultivated land should be reasonably easy. More difficult, but worth substantial effort, would be assessments of specific crop acreage. One of the problems we observed was that the farmers had no reliable information about what other farmers were growing and thus were likely to plan the same crop that many other farmers were growing and therefore risked planting a crop that would eventually be sold in a saturated market place. Any tool that could give an approximate indication of future crop yields would be highly useful. One of the saddest moments of our visit was to a farm family's house in Kerala. The farmers were award winners for their rice farming techniques. They were quite literally among the best farmers in India. Yet they were close to bankruptcy because they had leased land for the purpose of growing ginger. Unfortunately, many other farmers did the same and now the price is so low that any further efforts to cultivate the ginger just increases their losses. It was hardly a surprise for us to learn that the farmer's son wants to become a civil servant.

Farmers showing their national awards for rice growing

5. Reaching the Illiterate

One of the primary obstacles to access to information is literacy. A substantial number of smallholder farmers are illiterate by some definition. The use of text-to-audio is clearly going to be a principle method for making information available, but developing the system to the point where that process can take place in still a barrier that requires a solution. Microsoft Research in India is currently developing interfaces that use cartoon figures and common symbols to replace written instructions. The system also provides a video on the first screen that demonstrates how the system works and how the data being accessed got there in the first place. This is a concept that frequent users of the Internet and online data might never question, but it is easy to understand that someone with no technological background might find the billions of documents available on the Internet to be unnerving because it could appear that local computer contains all that data. Computer literacy for people who have never been exposed to computer technology requires a deeper level of assistance than it would for a person familiar with computer technology and the many virtual worlds where interactions with other people are performed in a mediated fashion.

This research starts to answer what are the important questions as to what issues are involved in reaching illiterate and first-time users of technology. We believe that the current work could become the starting point for designing a usable system for agricultural information to be used by the smallholder farmer.

6. WorldAgInfo Online System

The site visits were quite encouraging in terms of our investigation into the viability of a WorldAgInfo system. The WorldAgInfo online system is a conceptual test-bed for the principles and mechanisms of most interest to this project. The visits to Microsoft Research in Bangalore, India and to IWMI in Sri Lanka indicated that some of the key technical challenges we identified for a successful WorldAgInfo system are more than solvable; they are in working form and in some cases performing the tasks we envision for WorldAgInfo. It was also encouraging to see a number of efforts aimed at collecting and distributing agriculture information. Many of the people the team interacted were either interested in some sort of large-scale agricultural information repository or were working on components to achieve this goal. While some of these projects appeared promising, none of them incorporated the degree of feedback mechanisms essential to WorldAgInfo's operation nor did any of them look beyond their geographic or content focus.

The main lesson learned from the site visits in terms of WorldAgInfo is that partnerships that allow for WorldAgInfo to aggregate and distribute the materials of other projects will be essential. The technology for accomplishing this is not difficult; rather, it will be the letters of understanding that create a mutually attractive partnership that will be challenging. One of the primary obstacles to access to information is literacy. A substantial number of smallholder farmers are illiterate by some definition. The use of text-to-audio is clearly going to be a principle method for making information available, but getting into the system to the point where that process can take place in still a barrier that requires a solution. The Microsoft Research in

India is currently developing interfaces that use cartoon figures and common symbols to replace written instructions.

The screen below represents what an article on WorldAgInfo might look like.

V. Conclusions

1. Curriculum reform and enhancement at agricultural universities and other educational institutions in South Asia region – With the changing structure of agricultural markets, and the emergence of supermarkets, there is a need for market-driven curriculum reform and enhancement including agricultural marketing, food processing, food safety, food packaging, agribusiness, supply chain management, etc. In addition, the curriculum reform needs to encompass the new and emerging areas of science and technology including biotechnology, biosafety, intellectual property rights, geographic information systems, remote sensing, etc.

2. Human Capital Improvement – The human capital base in agriculture in South Asia is depleted. There is a serious need for continuing education and networking programs that link scientists and faculty members from South Asia with each other and with centers of excellence around the world through professional exchanges and sabbatical/study leaves. There is a need to improve incentives, recruit scientists and faculty members of international caliber.

3. New Models of Extension – Given that the current extension systems are not effective, there is a need for piloting new extension models such as the village level extension models and ATMA. Special attention should be given to the financial sustainability of public, NGO, and private extension models. The new pilot models should harness the modern ICT tools to help improve smallholder access to real-time information and new technologies.

4. Need for WorldAgInfo – A Global Ag Information Resource - With the new trends of globalization of the agricultural sector, there is a need for a global information resource encompassing diverse areas of agricultural research, education and extension. As a starting point, the WorldAgInfo resources should be piloted using the key priority areas identified by the Design Team prior to the South Asia site visit. The key challenge will be collaboration, partnerships, and intellectual property issues associated with information resources included in the WorldAgInfo. Our site visits confirmed our group's belief that a comprehensive information resource based, as envisioned in our WorldAgInfo functional overview document, is both feasible and necessary. The visit to Microsoft Research offices in Bangalore provided compelling evidence that some of the most technically challenging aspects described in WorldAgInfo are indeed possible. Other visits, such as that to the Indian Institute of Technology in Mumbai, demonstrated a belief that the aggregating and distributing agricultural information on a large scale was timely. WorldAgInfo has the potential to both extend the current agriculture information projects and to reinforce their impacts. However, it will be important to develop any system in consultation and collaboration with already existing large-scale agricultural information systems.

6. Enhancing Agricultural Libraries – Strengthening university libraries has the potential to significantly strengthen research, teaching and extension. The agriculture libraries need investments in the following areas:

- Development of institutional digital repositories for enhancing access to all types of publications, including multi-media.
- Collaborative E-Journals publishing for agricultural libraries throughout South Asia that would have access to journals from all of the universities. Libraries throughout the world would potentially subscribe to the collection as well.
- Digitization of graduate theses and dissertations for easy access and sharing of research findings from South Asia with the global community.
- Connectivity and equipment through high quality, high-speed reliable Internet access and adequate computers including literacy classes to teach students how to use online resources.
- Consortia purchasing of international journals to reduce costs.
- Acquisition of books and journals on emerging areas of agricultural research and development covering areas such as climate change, biotechnology, food processing, supply chain management, agribusiness, etc.

7. CGIAR Centers – Based on our visits to ICRISAT, Hyderabad and IWMI in Sri Lanka, we observed the increased pressures from donors in pulling CGIAR researchers downstream to work on development problems. Also, a number of Indian researchers expressed their concern about the lack of CGIAR attention in building the scientific capacity of NARS. This is a common problem throughout the CGIAR system and the one that deserves a major study over a period over the next 3 to 5 years. The CGIAR Centers have accumulated a wealth of knowledge and experience in specific areas and crops through global agricultural research network. Development of special modular learning materials (based on specific focus and strengths of CGIAR centers) in key areas by the CGIAR centers seems much more reasonable than undertaking any kind of degree offerings by the CGIAR. New forms of partnerships should be encouraged and supported, such as the one created by IWMI with the Imperial College in London to create learning modules on Water Resources and Water Management for a master's degree program.

8. Institutional Innovations in South Asia – Considering the weak linkages among institutions and programs in South Asia region, a competitive grant program should be initiated for enhancing inter institutional collaboration, cooperation and partnerships. These linkage programs should foster and build cooperation and collaboration between institutions within India, within South Asia region, between South Asia and Africa, and enhance linkages with advanced research and educational institutions globally. In addition, in an emerging era of privatization, the competitive grants program should foster public-private sector partnerships. This program could also be designed to encourage the inclusion of women in the inter-institutional partnerships, since in many institutions they are at a significant disadvantage.

9. Moving on Key Technical Hurdles – Our visits with various organizations involved in the testing and implementation of new technologies indicates that it is not too soon to begin large scale evaluation of key technologies, such as automated language translation.

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