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WorldAgInfo: 21st Century Agriculture Education and Information Systems Project

Terms of Reference and Overview

The WorldAgInfo Design Team was charged with exploring the landscape of agricultural education and information systems in South Asia and Africa. The goal of the project is to recommend potential areas of investment that will improve the effectiveness of agricultural education and training and ultimately the practice of small-scale agriculture at the local level. The team was specifically charged with identifying and exploring the feasibility of using collaborative technologies, such as community-based information systems and alternative information delivery mechanisms, to improve effectiveness of agricultural information systems. The report that follows addresses these goals and these four key project objectives:

- Identify agricultural curriculum/information needs of key stakeholders all along the education/information chain, including researchers, policy-makers, faculty, students, extension personnel, private sector input providers, large growers and smallholders
- Identify promising new technologies that can be adapted to agricultural information activities to improve the livelihoods of smallholders
- Explore the feasibility of using a Wikipedia-type model to create a "WorldAgInfo" system for developing collaborative community-based knowledge systems
- Explore the socioeconomic context of smallholders, including the institutions that support them, focusing particularly on ways to empower women as contributors and end users of collaborative agricultural information systems

The primary deliverable for this project was to be a final report recommending potential areas of investment to advance agricultural knowledge and information systems. The report that follows highlights strategies and technologies that offer particular promise.

Guiding Principles

The project operated under several guiding general principles:

1) The geographic focus areas for the project are South Asia and Sub-Saharan Africa. Because these regions are vast in size and extraordinarily heterogeneous, the team identified representative locations for closer study.

2) The primary beneficiary for potential information projects is to be the smallholder farmer. The team looked for opportunities where new technologies had the potential to significantly enhance the well-being of this group. The team coined the term "First Kilometre" to refer to the special problems in delivering agricultural education and information at the smallholder level. The team also looked for opportunities for successful intervention along the full agricultural education/information chain. This chain of multiple stakeholders, including researchers, faculty, graduate and undergraduate students, extension workers, agricultural input dealers, community knowledge workers, large commercial farmers, and smallholders, is a complex and interlinked ecosystem. The team worked under the assumption that successful interventions at any level could potentially enhance the livelihoods of smallholders.

3) The agricultural education and information needs of women were given priority during the entire project. In many parts of South Asia and Africa, women face a variety of barriers to full participation in agricultural education and information sharing. The project attempted to identify ways that new technologies could help reduce or eliminate these barriers.

The team drew many ideas and concepts from the background paper on "Agriculture for Development in Sub-Saharan Africa," prepared by John M. Staatz and Niama Nango Dembélé, at Michigan State University, for the World Bank's *2008 World Development Report.*

Project Components

The project consisted of 5 major components, each of which informed the others and enhanced the development of the set of potential support initiatives in this report. The project components are outlined here in brief.

1. Landscape Analysis

The agricultural information landscape is complex and interconnected. Traditional views of this landscape have described the triad of research, education and extension in primarily linear ways. Collaborative information technologies allow for new ways for these sectors to interact. The article following in this Section (1) redefines this landscape as a dynamic ecosystem and suggests a new set of tools for modeling the processes within the ecosystem.

2. Site Visits

Members of the WorldAgInfo team undertook 2 site visits as a first step in order to set the context for the rest of the project. A 5-member team travelled to South Asia (India and Sri Lanka) in June, 2007, and a 6-member team travelled to Africa (Mali and Zambia) in August, 2007. Each trip itinerary included visits with an extensive range of agricultural stakeholders and their related individuals and organizations, ranging from smallholder farmers to extension offices to large agricultural companies to government agricultural research facilities. Reports for each site visit are included in Section 5.

3. Literature Reviews

Team members and outside experts prepared literature reviews on key topics related to "First Kilometre" delivery of agricultural information. The reviews provided background for the Design Team on existing agricultural information systems for large and smallholder producers and an initial understanding of how the systems might be improved. Literature review authors surveyed the literature and described whatever issues arose in an institutional context.

In addition to informing our project, the literature reviews may offer useful summaries of key issues for Foundation staff. The literature reviews are available on the WorldAgInfo web site at www.worldaginfo.org.

4. Expert Consultation Workshops

Cornell International Symposium on Agricultural Education and Information Systems

- Workshop I: Knowledge Systems (Ithaca, New York, USA, October 2007)
- Workshop II: Delivery Systems (Livingstone, Zambia, November 2007)

The team organized two workshops which brought together leading experts in agricultural education in Asia and Africa to work alongside experts on emerging collaborative information technologies. The workshop agendas lead to discussion of current and optimal practices in agricultural education and information delivery in rural areas of Asia and Africa. Each workshop was divided into smaller groups which were charged with developing ideas for solving key problems in agricultural education and information systems. Ideas developed at Workshop I held at Cornell in October 2007 were used to jumpstart creative thinking at the second workshop a month later in Livingstone, Zambia. Section 3 of this report includes the short concept notes developed in the first workshop and Section 2 includes the more developed proposed initiatives that were generated by the Zambia workshop.

5. Smallholder Surveys

To supplement the Design Team's observations during the site visits, an informal survey was undertaken to pull in additional anecdotal evidence regarding key problems in access to information at the smallholder level. Students from universities the Design Team visited in India, Sri Lanka, Mali and Zambia assisted us in gathering information about where smallholders get their agricultural information and what barriers they face in obtaining accurate, up-to-date information. While not a scientific study, the interviews with smallholders provide confirmation of many of the observations made during the site visits. A brief summary of the survey is presented in Section 6.

Conclusion

As agreed in our Terms of Reference, this final report proposes a series of 12 support initiatives related to agricultural education and information systems. The ideas for these initiatives came primarily out of the November 2007 Zambia Workshop. The proposals describe the initiatives in some detail, but any attempt to implement any of these proposals requires additional decisions about partners, staffing, and budgets.

Proposals were created by individuals and small teams, and they do not always have full team consensus and unqualified support. They do, however, represent the best creative thinking of the Team and our many colleagues who contributed in one way or another to the development of these ideas.

In addition to the 12 full proposals and 30 brief concept papers Design Team members produced another 50 ideas for opportunities to improve agricultural education and information systems during the course of this project. Due to time constraints the members weren't able to develop the ideas further. These are listed in Section 4.

The Agricultural Information Landscape—New Tools for Analyzing Dynamic Systems

Agriculture was the foundation and organizing activity of humanity's first civilizations but that does not mean that it is well understood. Analyzing agricultural processes has become increasingly difficult as the agricultural environment grows ever more complex. Among the elements that add to that complexity are the introduction of new technologies, the creation of global markets, the impact of rapid environmental changes, the pressures of population growth, the disruptive influence of urbanization, and the flood of new information sources relevant to even the smallest scale farmer.

All aspects of agriculture present challenges to analysis, but agricultural education and information systems are particularly resistant to traditional methods. These mirror the complexity of the overall agricultural environment and present similar problems of analysis, while adding some unique problems of their own. Additional methodologies are required to understand processes and relationships in agricultural information. Only with that understanding will we be able to match needs with solutions and apply effective ideas on a global scale.

Policy makers and planners have used a variety of models to analyze agricultural processes. Frequently used analytical tools such as hierarchical organizational charts and cost-effectiveness studies give the impression that agricultural systems can be described by static relationships and predictable interactions. Traditional models, particularly of information systems, are generally top down and fail to value local knowledge, nor do they facilitate sharing and transportability.

Although these tools still have value, used alone they will not prove adequate to the task of understanding modern dynamic agricultural systems, which is the first step in designing projects that will have a successful impact on complex problems such as alleviating the plight of smallholder farmers. Anyone seeking to understand agricultural systems requires more powerful analytic models, which take into account the complexity and dynamism of those systems.

Experience shows that having a better design for an irrigation canal or a seed with 30% better yield is not enough to have a lasting impact in the local agricultural environment. Only after understanding information flow and distribution can we begin to implement effective solutions.

The Agricultural Information Ecosystem

Because information systems consist of human actors and the interactions and the interconnectedness of information resources and behaviors, we propose to conceptualize information systems as ecosystems. An ecosystem model will allow us to understand the processes of information creation, distribution, and comprehension. We can develop our analytical tools with this model in mind.

Four distinct methodologies are used to describe ecosystems. These are easily adapted to describe the special case of information ecosystems.

1. Structural Analysis: describing the mechanics of actors
2. Process Analysis: analyzing the interactions of actors

One can also describe the environmental factors (operational and structural) in which the actors and interactions reside with these methodologies:

1. Operational Principle Analysis
2. Structural Principle Analysis

These approaches can be used together to systematically analyze a complex environment:

- Use structural analysis to identify actors in an environment and their basic relationships to one another.
- Apply structural analysis to isolate a targeted project so that the individual processes can be identified.
- Analyze each process in terms of the cyclical elements that comprise it.
- Identify activities, costs, and values to each element of the process so that an overall valuation of the process can be made.
- Analyze the operational and structural principles involved in the process in order to evaluate the ability of the process to function effectively.

Structural Analysis

The framework of the agricultural information ecosystem (Figure 1) describes agricultural information actors and their relationships to one another. For the sake of analysis the actors are assigned to major groups: farmers, frontline workers, researchers and educators. Although many of the framework's interactions have hierarchical elements, the ecosystem model encourages the user to see other possible relationships.

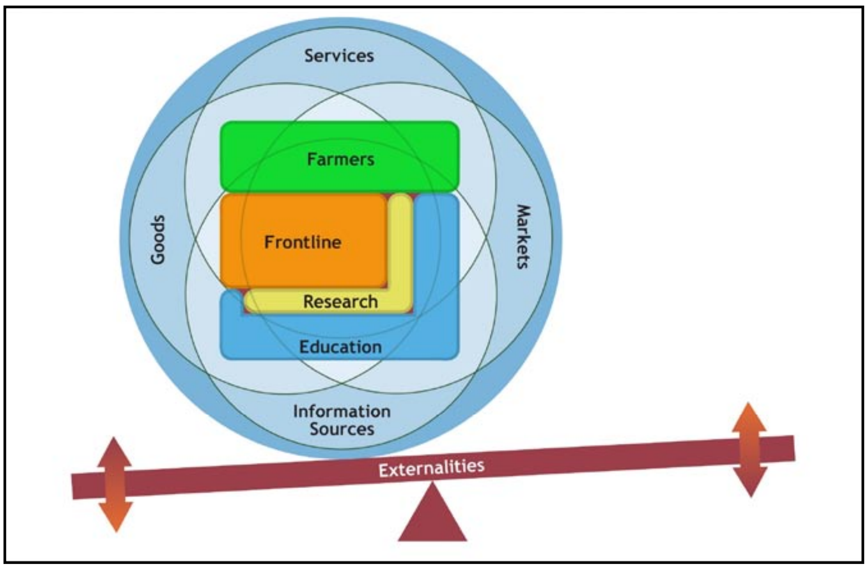

Figure 1: Agricultural Information Ecosystems

Another advantage of this model is that it recognizes that information may flow in multiple directions simultaneously. Although a hierarchical model might show information flowing only, or primarily, from frontline workers to farmers, in this model we have the ability to describe farmers' communication with frontline workers. Once the possibility of bidirectional flow is established a more realistic analysis of agricultural information processes is possible.

The size of each grouping of actors in Figure 1 represents very roughly the relative size of the population of each actor group, for example, there are fewer researchers than educators. The degree of contact between actors is represented by the surface contact of each block in the schematic. Researchers in this model have the greatest contact with educators, but also have some contact with farmers and frontline workers. These are, of course, generalizations. In specific cases private researchers may only contact farmers, and frontline workers may rarely interact with educational institutions, but the generalizations will help us understand the processes at work in agricultural information systems.

The second component of the framework is the set of surrounding circles. The areas of goods, services, markets, and information sources indicate resources available to the actors. The circles overlap to show that they, too, interact with each other both within the environment of the actors and outside of them.

The last major element is the constantly shifting fulcrum of external forces. These forces range from being completely uncontrollable (e.g., wars, weather) to somewhat controllable (e.g., government policy and local infrastructure). Understanding the local agricultural information system requires acknowledging that the landscape is constantly being impacted by external forces.

The Agriculture Information Ecosystem gives us a holistic perspective which will prove useful for further analysis, but as useful as it is, it does not provide us with enough information to analyze a specific information-related project, much less to take any specific action. The Agriculture Information Ecosystem is the equivalent of a high-altitude photograph, good for understanding the major features and contours but not useful for mapping specific routes.

The Applied Project Information Flow graphic (Figure 2) allows us to analyze the activities of individual projects within the Agriculture Information Ecosystem. A project, as defined here, incorporates some or all of the actors in the Agriculture Information Ecosystem, but isolates a subset of related activities from the myriad of activities possible in the ecosystem.

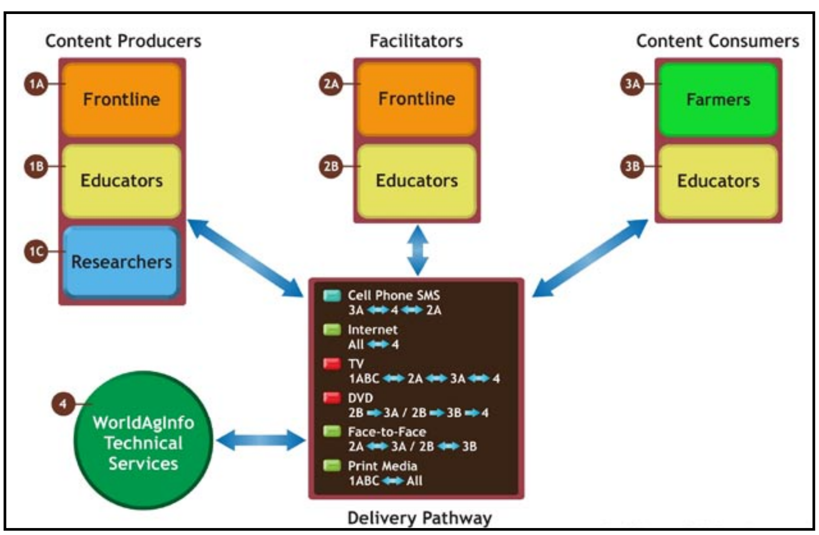

Figure 2: Applied Project Information Flow

Figure 2 identifies the communication flows found in the Multimedia Knowledge Exchange Systems for Smallholder Farmers proposal, a project analyzed in detail in section 2 of this report (Proposal 8). The structural elements of the Agriculture Information Ecosystem are represented in the chart. We see the actors organized according to their roles in this particular project. Now, however we have added a representation of the information flows between the structural elements (with a blue line and bidirectional arrows). These flows are the processes that are central to an analysis of the Multimedia Knowledge Exchange Systems Project.

Applied Project Information Flow Explained

Figure 2 arranges the actors into the specific relationships found in the project. All the communication flows are described in the Delivery Pathway box. The box is something akin to an old style telephone switchboard in that it shows a link between two points. The box describes the flows by listing the numbers of the origin and destination actors. The arrows show the direction of the communication flow. The media names indicate which medium is being used. The colored boxes to the left of the media names give a quick view of the communication flows: blue is incoming only, red is outgoing only, and green is bi-directional.

Although the Project Information Flow Chart is useful in describing a project's structures, relationships and processes, it does not isolate each process for analysis. The chart cannot represent the difference between a working process and a malfunctioning process. Thus, another analytical tool is needed to move beyond simply representing a process to making some determination about its effectiveness.

Agriculture Ecosystem Processes

Effective analysis of information projects within the Agriculture Information Ecosystem takes place at the level of the process. Processes combine to create projects and other recognizable activities. They are inherently dynamic. Healthy information-based processes are characterized by a cycle of creation, transformation, distribution, processing and action, with a return to creation as feedback is incorporated into the next cycle. We call this dynamic and iterative cyclical process an "Infovation Cycle." The graphic of the Infovation Cycle Analysis (Figure 3) represents both the flow of information and the act of innovation.

Each element of the cycle can be assessed by using a simple table. In Figure 3, the table at the right identifies elements found at each stage of the process and characterizes their important elements, such as cost, performance, probability of success, and the application of values. All of these elements can be rigorously analyzed.

Infovation Cycle Stages

Creation

Every Infovation process starts with some act of creation. Creation can be initiated by any actor in the system. The Creation stage grows out of the Action stage as feedback generates newly created content for the next iteration of the cycle.

Transformation

In most situations, the creation of information also requires its transformation into formats, styles and levels of abstraction suited for the intended audience of the project and its targeted distribution systems. When researchers create information and share that information with colleagues in the same discipline, they transform that information into formats required for journal and conference submissions. If that information is to be useful to farmers, it must be transformed, abstracted, and possibly translated into other more simplified formats.

Distribution

Distribution mechanisms within an Agricultural Information Ecosystem include newspapers, flyers, radio, cell phones, television, and the Internet. In a strict analysis, one would want to evaluate each distribution mechanism in detail. In the Internet age, however, the costs of many distribution systems are so low that it is desirable and cost effective to distribute information as widely and redundantly as possible.

Processing

Processing, which we define here as translating information into forms understandable to the recipient, is especially important in the realm of agricultural information. The high level of illiteracy among smallholder farmers, the group most in need of information, can be overcome only by re-presenting any written information in some other form. Even when smallholders are literate, that literacy may be in local language or dialect, rather than the official language of the country and so will require translation, another form of processing.

Action

Once the recipient has the information, some form of action should take place. Smallholder farmers are highly motivated and usually will look for any information they believe can help them out of poverty, or merely to subsist. When inaction occurs it can be due to the inability to undertake a desired action, a lack of understanding, a disagreement with the message, or some other block. Both actions and inactions, properly analyzed, generate feedback into the cycle to improve the process.

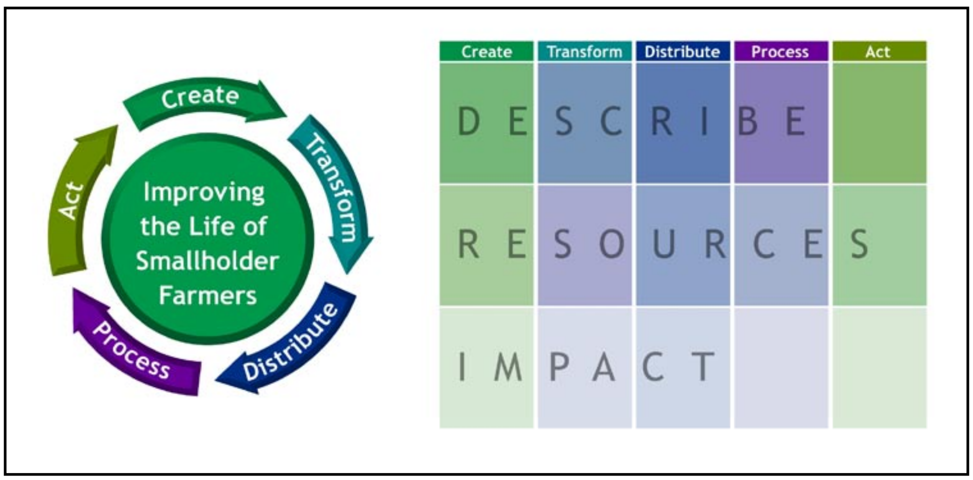

Figure 3. Infovation Cycle Analysis

Infovation Cycle Measurements

The Infovation Cycle approach states that all stages must function well for the process to function. Furthermore, a healthy system is dynamic and imbued with the ability to grow and develop.

The Infovation Cycle approach, as opposed to many traditional approaches, has the ability to incorporate and represent values. We use the term "value" to define the assumed goals of a process or actors within it. Values can be both implicit and explicit. One basic implicit value is that stated above: a healthy process cycle will be able to grow and change in order to achieve its goal. The explicit values are those of the people performing the analysis. Their values may be stated as goals: the improvement of the condition of women or the creation of content in under-represented languages.

Performing this Infovation Cycle analysis is useful for looking at an individual project, but it is equally useful in identifying intervention points within an environment (e.g., region, country, sector, technology, etc.). Because the costs, scope and values have already been applied through use of the process analysis, researchers can identify meritorious elements in a complex environment.

Additionally, a planner or project designer looking for intervention points now has a basis to analyze many projects at once for common opportunities. For example, a number of possible projects might all benefit from a common service. This perspective is the key to providing leverage and scale to future interventions.

Infovation Cycle analysis may appear only well suited to analyzing current processes but unable to be predictive due to the nearly infinite number of potential solutions for a problem. In reality, the number of potential elements is quickly reduced by what is possible in each environment, by obvious costs limitations, and by the examples of past successes and failures. And by its very nature an Infovation Cycle can survive a less than optimal solution set as long as the iterative characteristic remains.

Just as a biological ecosystem dies when its dynamic flows fail, the heart of an information ecosystem process is feedback and repeated iterations. Incorporating feedback can be challenging. Societies tend to use measurements for allocating praise or blame and not as an integral part of an analytic process. In this model, praise should be directed at actors who help the feedback process and blame reserved only for those that hinder it. The result of feedback is learning, and the information it produces is always valuable.

Operational Principles

An information ecosystem is built from a multitude of synergistic components. Some of the operating principles of the new agricultural information ecosystem include:

- Redundancy of sources and access nodes - the availability of information from multiple sources through multiple delivery systems
- Universal, constant feedback – recording and sharing the experience and opinions of all stakeholders
- Universal "voice" - most notable is the addition of the voice of the smallholder
- Unprecedented collaboration of all participants – everyone recognizing that they are both teachers and learners
- Rapid prototyping with constant feedback and intense, real-time collaboration of all stakeholders

When these operating principles are in place the potential learning curve is compressed from decades to years to months and in some instances to near real time.

Operational Principles: Redundancy as a special case

The famous line of Robert Burns's "To a Mouse," "The best laid schemes o' mice and men gang aft a-gley," applies especially well in the difficult environments of Africa and South Asia. These landscapes are littered with the literal and figurative debris of failed plans. While there are, of course, many elements that are critical to a project's success, we believe that success is far more likely if planners in the agricultural information ecosystem adopt a strategy of redundancy. In fact, redundancy should be promoted to the level of an operational principle.

Figure 4 shows one way that redundancy can be enhanced in an information system. The directional lines represent four otherwise independent projects focusing on the smallholder farmer. The center set of four circles represents the four principal areas within which each of the proposed projects fall. The areas overlap with one another in the schematic and it is along the horizontal plane of this overlap that redundancy can be enhanced. So, for example, a project involving a wiki-based knowledge system in the university environment may be supported by some of the system's content finding its way to the smallholder farmer, not only through university researchers and agricultural extension officers, but also through a radio-based agricultural educational project.

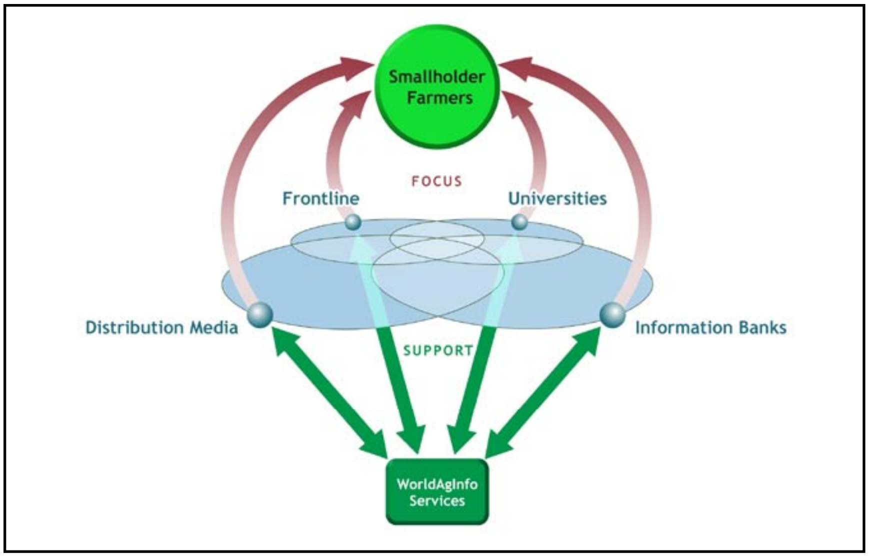

Figure 4: Project Support Structure

The graphic also illustrates the value of clustering related projects. One of the lessons of the Internet is that once valuable content has been created, the cost of distributing it through other information channels is usually very low. Related projects such as those shown here can easily reuse and repurpose content created for any one of them.

Projects can also be clustered by their common technological needs. In the past, a project might fail because its planners did not understand how to use an available technology in an effective way. This graphic shows how a common technology support system, in this case, WorldAgInfo Services can provide multiple technologies in support of several similarly focused projects. Projects with mutual advantages can be developed and lessons from one project may be shared with other projects. In terms of redundancy, a common support system also allows one project confronted with a technological barrier to quickly identify alternative solutions. So, in the hypothetical case of a country closing down all community radio stations for political reasons, a project based on community radio might be able to shift to cell phones or to distribution via a podcasting model.

Operational Principles: Trust as a special case

Billions of dollars have been spent to help the smallholder farmer with limited results. When success has been achieved, the results do not seem to be widely transferable. Many assume that the lack of progress has been due to the lack of education or an unreasonable adherence to outdated traditional practices. Our design team found that, on the contrary, smallholder farmers are sophisticated in their analysis of their environment and open to new ideas.

Smallholder farmers constantly analyze what they should grow, how it should be grown, whether they should work in the city and hire laborers, and if and when to buy and sell in the market. A wrong decision can easily result in losing their land, lowering their standard of living, or even losing their lives.

But any form of analysis requires trustworthy data. Accuracy, predictability and repeatability are a few of the factors which lead to trust. Their opposites—inaccuracy, unpredictability and unrepeatable results raise obstacles to trust. Often the smallholder does his/her analysis in information environments that are untrustworthy to varying degrees. Smallholders are frequently unsure if the price they are receiving is fair, for example, or if the product being purchased is unadulterated. Regulations may be enforced selectively and fee-based services may be difficult to negotiate.

Trust is a key element to maintaining a successful information process. Even if the immediate goal of a project has been met successfully, if trust is not maintained the result is failure over the long term. Those directly involved may be able to see a project's success, but once the face-to-face contact of trusted participants ends, they frequently will lose the confidence to influence others.

Relevance is a related issue. A smallholder may understand that the information s/he is receiving is correct and that the person presenting the information has no ulterior motives, yet the information may not be suited for local conditions.

Trust is relative to the situation and the experiences of the individuals involved. Unfortunately, because smallholder farmers cannot afford to make mistakes and because they have traditionally operated in challenging information environments where trust was absent, the level of effort required from information providers to obtain trust is very high.

Trust is most easily achieved at the level of grass-root organizations, such as farmers' cooperatives and women's groups. Agriculture information ecosystems linked to these solid foundations of established trust may become one of the best pathways out of poverty.

Additional operational principles that increase the potential for trust and success are:

- Transparency
- Formative evaluation
- Interdependence
- Diversity

Even if many elements in the environment remain untrustworthy, if an agricultural information ecosystem can be built which gains the trust of the smallholders, it will succeed in offering them new options for action and response.

Structural Principles

As we have noted, a healthy Infovation cycle has growth and change as essential ingredients. Without them one can have a successful project that is the equivalent of a model ship in a glass bottle. It may be wonderful to point to and highly admired, but has no real utility or applicability. It will never set sail. We need to adopt a set of structural principles to insure dynamic, sustainable projects.

A successful project must include most of the following structural principles for maximum results:

- Scalability
- Replicability
- Modularity
- Multiple models

The relationship of these two sets of operational and structural principles to the Infovation cycle is illustrated by Figure 5. The graphic shows how combining the two sets of principles propels the iteration process. If the project has multiple sound structural principles, but the operational principles are poorly represented or weak, the project will be awash in resources and good ideas, but is unlikely to make progress.

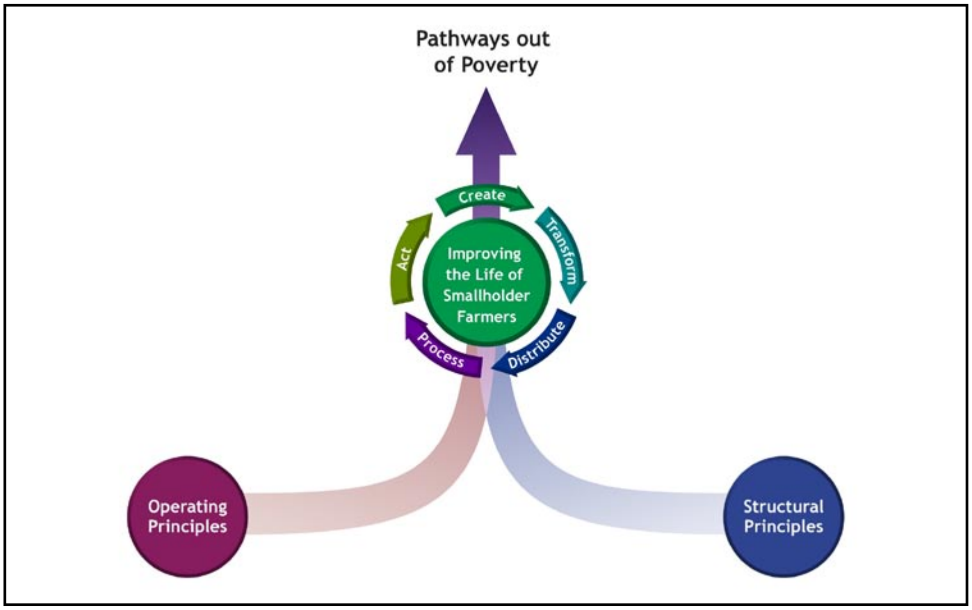

Figure 5: Information Ecosystem Principles

On the other hand, if the operational principles are strong, as is the case with many grass-roots organizations, but the structural principles are weak, then however successful the project is it will have difficulty sustaining itself and is unlikely to spread to other communities.

A successful project requires the optimal mix of appropriate structural and operational principles.

Conclusion

In 1597 Sir Francis Bacon said “Knowledge is power” (Scientia potentia est). Knowledge is based on information. Today the world has generated and continues to generate even more information than the most educated person can ever use or access incrementally. Today we need an update to Sir Francis’ dictum. We propose the obvious, “The management of information is power.”

The world information ecosystem is reeling from information chaos. It was only 150 years ago when the soon to be founders of the Oxford English Dictionary formed an “unregistered words committee” to bring new order to the use of the English language. From that modest beginning, the publication of the first ten-volume edition of OED (really twelve volumes as volumes 9 and 10 were published as two half volumes each), took more than 75 years. Information was generated at a modest pace, and the collation of information was being transformed as well. By the time the last fascicules were published, the information was orders of magnitude more extensive, but finally under control—for that brief moment in time.

Our current education system, of which agriculture education is a part, is still organized around that 19th century compendium of knowledge and its mastery. New information has been grafted on to an old, established knowledge order. What is needed is a new information order, a new information ecosystem that is organic by its very nature and tuned to future growth.

The operational and structural principles discussed here are not the only principles of a new information ecosystem, but are among the emerging principles which, if better understood and incorporated into project development, will provide better options for new pathways out of rural poverty.

We believe that the tools discussed above may be useful for evaluating a wide range of human activities. They are essential for evaluating human activities in cultures and environments in which we are not native participants. Like biological ecosystems, the processes of information systems are fundamental but the actors and interactions vary. Many projects have failed because they attempted to reproduce the specifics of their native ecosystem and transfer it unmodified to another ecosystem. These tools help us to understand what made one ecosystem successful and then allows us to transfer those successful elements to other environments.

In the same way that many businesses fail in our culture when they appear to be destined for success and other businesses succeed against all reasonable expectations, we must allow agricultural information processes in the developing world to function in such a way that what really works can succeed and provide the building blocks for further success. At the same time processes that merely appear successful but which eventually fail should still provide us with information to design a better process.

Agricultural information is a human activity that takes place in a human environment. The key principle for success is to trust in the human process. When people can function well in a process, success will be the outcome.