PEOPLE AND AGRO-ECOSYSTEMS RESEARCH FOR DEVELOPMENT CHALLENGE

PRODUCT LINE PA-1:

MARKETS, INSTITUTIONS AND LIVELIHOODS

Annual Report 2007

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ANNUAL REPORT 2007

PEOPLE AND AGROECOSYSTEMS RESEARCH FOR DEVELOPMENT CHALLENGE (PA RDC)

Product Line PA1: Markets, Institutions and Livelihoods

Introduction

This new Product Line aims to deliver innovations, mostly in the form of approaches, methods, tools and policy options, that contribute to improving the effectiveness of agricultural research and development and the uptake of research results by small-scale farmers. Above all, PA1 aims to ensure that the strategies, approaches and methods employed and advocated by CIAT are appropriate for benefiting the hard-to-reach, and especially the poor, which include many female farmers in Africa, Asia and Latin America.

The tropical world is characterized by considerable variation at many scales. Agroecological conditions tend to be most varied in hillside agriculture. Markets are often undeveloped, distant, poorly informed, and especially imperfect in the way they serve the poorer, small farmers. Institutions at all levels from village to region tend to be numerous, and at varying levels of effectiveness, inclusiveness and governance. Small farmers' livelihoods range from near-subsistence to small scale commercial (although pure subsistence is less common than is sometimes thought), and households may seek or have opportunities to emerge from poverty in ways that differ according to their composition, agroecological situation and socioeconomic circumstances.

Both social and biophysical outcomes are needed to achieve widespread impact under these conditions. Development and research practitioners need tools that enable them to work at different scales, and to discriminate effectively among rural populations and environments. Many of the most appropriate tools will be interdisciplinary in nature, and in general need to be derived through iterative interdisciplinary research processes. Agricultural science practice cannot be successful if it is disconnected from development practice, and some of these research processes need to be embedded in development (research for development R4D) in order to yield robust and international public goods.

PA1 on *Markets, Institutions and Livelihoods* aims to address several aspects of the System Priorities 3, 4 and 5, by addressing key research questions around systems approaches (targeting, systems integration, organizational models, reaching end users, learning approaches and impact assessment). We expect outputs from PA1 to increase the effectiveness of other product lines of CIAT, as well as the wider R4D community. Some outputs contribute directly to those of other Product Lines through teamwork with biophysical scientists, and may be reported elsewhere. This Product Line incorporates previously separate CIAT Projects on *Tropical fruits, Crop and agroecosystem health management, Rural agroenterprise development, Participatory research approaches, and Spatial and economic analysis for decision and policy support in agriculture and the environment.* In this transitional year, this annual report for PA1 is presented in the format in which our work was organized throughout 2007 (and which first appears only in the MTP 2008-2010). However, we have maintained in this report the Output Targets formally approved in the MTP 2007-2009, reorganized into the five Outputs of PA1. Reports are mostly

in the form of published abstracts or summaries, with full papers or reports being available elsewhere (including in many cases on the CIAT website).

7. Abstracts, papers and reports

Output 1. Institutional arrangements for increasing impacts

Introduction

The CGIAR's framework for System Priority (SP) 5C – Improving rural institutions and their governance – recognizes that SP areas 1 to 4 cannot be achieved without strengthening the organizational capacities of smallholder farmers and of rural service providers. We need better understanding of how the roles of organizations in the rural research and development sector are changing, how they function best in different settings, and the most effective approaches to strengthening their capacities for innovation. In doing so, we create or maintain resilient agroecosystems and support rural people to break out of the poverty trap. We draw lessons for strengthening the participation and influence of the poor in land and water management through assessments of the effectiveness of approaches, methods and institutional arrangements as promoters of pro-poor interventions.

Interventions need to be well targeted and we need methods for evaluating their effectiveness. Work reported below includes a comparison of participatory and other methods for poverty assessment. In the context of the eastern Africa highlands, we examine prevention and management of conflicts, which are often a feature of natural resources management. Social capital of different types proves useful to communities in some cases but is not effective in other cases, so communities also rely on formal mechanisms for arbitration. Building this synergy between the formal and informal seems to be important in this context. One of the interventions we examine here is the fostering of community participation with local government in the reform of bylaws that govern the management of natural resources, although elements of social exclusion and inequality (including by gender) still come into play.

We examined methods for improving the targeting and reach of agricultural research institutions, as well as how the poor can better contribute to the agenda of the formal research sector and lead some types of experimentation. CIAT tools for spatial analysis have potential for wider application in the context of the sub-Saharan Africa Challenge Program. We also determined the relevance, accountability and impacts of multi-stakeholder agricultural innovation platforms (partnerships between farmer/civil society organizations, and private and public sectors) in a range of settings in the context of work with our partners in eastern and southern Africa on enabling rural innovation. We developed understanding of how participation strengthens innovation systems through a comparison of approaches across projects and partnerships established for or working towards a range of purposes in Latin America and Asia. An examination of the use of D-groups showed that such communities of practice need more than a common virtual space and connectivity: it is necessary to build on the skills and interests of the active membership.

We analyzed methods for tracking change, improving learning and assessing livelihood impacts in a set of case studies in eastern and southern Africa. We examined the use and limitations of community-identified indicators in participatory monitoring and evaluation (PM&E) across Malawi. Working jointly with researchers in Kenya, we also examined lessons for the institutionalization of and the effects of incorporating local perspectives upon the decision making and accountability of a research system. We determined the utility of impact pathways

(an approach reported upon more extensively last year) in ex-post impact assessment in the context of the Challenge Program on Water and Food.

Research towards this output is closely linked with that in Outputs 2 and 5, and facilitates understanding of the institutional aspects of smallholder participation in market chains. It also facilitates developing the potential of payment for environmental services generated from agriculture to improve both the environment and rural livelihoods.

Dinámica y definición de pobreza en los Andes colombianos: Enfoques participativos vs. enfoques objetivos [Dynamics and definitions of poverty in the Colombian Andes: Participatory vs objective approaches] [SCALES project]

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Abstract

The objective of this study is to examine the consistency of results of a participatory, poverty assessment methodology applied in two Colombian watersheds with those from more objective approaches. The results suggest that there is a set of elements that are considered basic to both types of poverty assessment, however at the same time there are others that depend on household and community preferences. Moreover, the results indicate that the concept of poverty is context specific: a household that is considered poor in one community may not be considered poor in another. The results of the participatory methodology are useful to identify who the poor are, why they are poor, and provide a better understanding of the nature and dynamics of poverty. However it may not be appropriate to generalize on the basis of the results of such methodologies since the results may differ in both nature and magnitude from the results of objective poverty measures.

Published

Desarrollo y Sociedad (2006). Issue No. 58, pp 209-243.

Analysis of biofortification of the commercial variety of common bean (*Phaseolus vulgaris* L.) Calima in Colombia

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Abstract

Nutritional deficiencies of Fe and Zn are considered a public health issue. Biofortification of crops such as bean (*Phaseolus vulgaris* L.) is proposed as an alternative to address these nutrient deficiencies. NUA(Nutrición Andina) advanced lines of common bean have been developed in order to improve Fe and Zn content for commercial Andean red-mottled "calima" types in Colombia. These lines have been in agronomic trials since 2003 and are currently being considered for release. During the testing process, genotype-environment (GxE) interaction has been found to be an important factor in the accumulation of these nutrients. This project, therefore, reviews the experimental results obtained to date to identify those lines with higher stability and to determine which soil or climatic variables are associated with the GxE interaction. An additional objective of the work has been to predict the geographic regions in which to continue with testing of NUA lines and to target potential release of these genotypes. NUA35 was found to be the genotype with the highest stability and average content of Fe and Zn in all environments. A principal component analysis (PCA) with soil, climate and yield variables of all trial sites allowed the identification of two different variable associations, the first one related with pH and cation exchange capacity and the second, with organic matter content, precipitation and soil Fe content. High seed Fe content was found in places with high soil Fe content or higher pH values. Specific studies are proposed to define pH ranges, critical soil Fe or other nutrient levels that would allow a suitable phenotypic expression of the Fe accumulation potential of the biofortified NUA lines. Finally, using Homologue™ and other spatial analysis tools, it was possible to identify potential production zones to continue with experimentation and release of these genotypes.

A new global demand for digital soil information

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Abstract

The question has to be asked why - given the substantial advances in quantitative techniques over the years – 'full' Digital Soil Mapping has not been mainstreamed further and harnessed to the problems soil information can help address. This paper suggests some reasons for a slow adoption, causes for optimism for a wider adoption than at present and – using a case study from Honduras – demonstrates the ease of further development at national scale. Finally, we propose how a major effort of digital soil mapping could support development in Africa, outlining the opportunities and obstacles that await contributors.

Publication

Hartemink, A.E., McBratney, A.B., Mendonça Santos, M. L. (eds.) *Digital Soil Mapping with Limited Data*. Elsevier: London. (In press).

New global hydrography derived from SRTM elevation data

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Abstract

Although countless river maps exist for well-studied river basins and individual nations, there is a lack of seamless high-quality data on large scales such as continents or the entire globe. Data for many large international river basins are patchy, and remote areas are often poorly mapped. In response, a team of scientists has developed data and created maps of the world's rivers that provide the research community with more reliable information about where streams and watersheds occur on the Earth's landscape and how water drains from the land surface. The new product, known as HydroSHEDS, provides this information globally at a resolution and quality much better than that of previous data sets. For some regions of the world, such as the Congo Basin in Africa and parts of the Amazon Basin in South America, HydroSHEDS provides the first high-resolution, seamless digital river maps for these systems, which were previously only poorly mapped.

HydroSHEDS is based on elevation data obtained during NASA's Shuttle Radar Topography Mission (SRTM) and stands for "**Hydro**logical data and maps based on **SH**uttle **E**levation **D**erivatives at multiple **S**cales". The kind of hydrographic information provided by HydroSHEDS allows scientists and managers to perform analyses ranging from basic watershed delineation to sophisticated flow modeling. At the most basic level, HydroSHEDS will allow users to create digital river and watershed maps. These maps can then be coupled with a variety of other data sets or applied in computer simulations, such as hydrologic models that estimate flow regimes.

HydroSHEDS was developed by the Conservation Science Program of World Wildlife Fund (WWF). Data have been completed for South and Central America, Asia, and Africa. These data are available for download from the U.S. Geological Survey’s EROS Data Center. The remaining land masses of Australia, Europe, and North America will be successively released at intervals of 2-3 months.

Publication

Earth Observation Systems (In press) (2008).

Digital soil mapping of soil properties in Honduras using readily available biophysical datasets and Gaussian processes

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Abstract

Creating detailed soil maps is an expensive and time consuming task that most developing nations cannot afford. In recent years, there has been a significant shift towards digital representation of soil maps and environmental variables and the associated activity of predictive soil mapping, where statistical analysis is used to create predictive models of soil properties. Predictive soil mapping requires less human intervention than traditional soil mapping techniques, and relies more on computers to create models that can predict variation of soil properties. This paper reports on a multi-disciplinary collaborative project applying advanced data-mining techniques to predictive soil modelling for Honduras. Gaussian process models are applied to map continous soil variables of texture and pH in Honduras at a spatial resolution of 1 km, using 2472 sites with soil sample data and 32 terrain, climate, vegetation and geology related variables. Using split sample validation, 45% of variability in soil pH was explained, 17% in clay content and 24% in sand content. The principle variables that the models selected were climate related. Gaussian process models are shown to be powerful approaches to digital soil mapping, especially when multiple explanatory variables are available. The reported work leverages the knowledge of the soil science and computer science communities, and creates a model that contributes to the state of the art for predictive soil mapping.

Publication

Hartemink, A.E., McBratney, A.B., Mendonça Santos, M. L. (eds.) *Digital Soil Mapping with Limited Data.* Elsevier: London. (In press).

Conflicts management, social capital and adoption of agroforestry technologies: Empirical findings from the highlands of southwestern Uganda

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Abstract

In the highland ecosystems where actions by some individuals or groups often generate off-site effects among a wide range of social actors and stakeholders, the use and management of natural resources are susceptible to multiple forms of conflicts. This paper examines the hypothesis that conflicts constrain the adoption of agroforestry technologies. Using empirical data from 243 households in Kabale, Uganda, the study identified over 780 different cases of conflicts, and found positive relationships between certain types of conflicts and adoption of agroforestry technologies. The results of this paper challenge the conventional wisdom that conflicts are pervasive, and that the prevalence of conflicts is a major barrier to the adoption of NRM technologies. On the contrary, they seem to suggest that conflicts may have some positive outcomes; they provide incentives for the adoption of NRM technologies, and can be a potential force for positive social change. Conflicts are an essential feature of NRM in the highland systems and cannot therefore be ignored. What matters is the ways such conflicts are managed and resolved, and transformed into a force for positive change. We found that three dimensions of social capital (collective action, byelaws implementation and linking with local government structures) have increased the ability of communities to manage and transform conflicts into opportunities for collective action. These findings suggest new areas for further investigation to improve understanding of adoption decisions and building local capacity for scaling up the impacts of agroforestry innovations.

Published

Agroforestry Systems (2007) **69:**67–76.

Gender equity and social capital in small-holder farmer groups in central Mozambique

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Abstract

This case study from Búzi district, Mozambique investigated whether gender equality, in terms of male and female participation in groups, leads to gender equity in sharing of benefits from the social capital created through the group. Exploring the complex connection between gender, groups, and social capital, we found that gender equity is not necessarily achieved by guaranteeing men and women equal rights through established by-laws or dealing with groups as a collective entity. While there were no significant differences in the investment patterns of men and women into groups in terms of participation in group activities and contribution of communal work, access to leadership positions and benefits from social capital were unequally distributed. Compared to men, women further found it difficult to transform social relations into improved access to information, access to markets, or help in case of need.

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The dynamics of social capital and conflict management in multiple resource regimes: A case of the southwestern highlands of Uganda

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Abstract

Increasingly, social capital, defined as shared norms, trust, and the horizontal and vertical social networks that facilitate coordination and cooperation for mutually beneficial collective action, is seen as an important asset upon which people rely to manage natural resources and resolve conflicts. This paper uses empirical data from households and community surveys and case studies, to examine the role, strengths, and limits of social capital in managing conflicts over the use and management of natural resources. We inventoried over 700 cases ranging from conflicts between multiple resource users to supracommunity conflicts between local communities concerns for better livelihoods and national/international concerns for environment conservation. Results show how different types of social capital are used in preventing and managing conflicts. Endowment in certain dimensions of social capital significantly decreased the occurrence of conflicts and played a significant role in managing them. However, social capital mechanisms have some limits, and are not always effective in resolving some types of conflicts. For such conflicts, people rely on formal mechanisms for arbitration and adjudication. In many cases, these have resulted in exclusion, coercion, and violence. Results show that policies or social capital alone do not possess the resources needed to promote broad-based and sustainable conflict resolution strategies. Rather, people use a range of conflict management strategies of different types and combinations of social capital and local polices. This synergy between social capital and local policy is based on complementarity and embededness: mutually supportive relations between local government and local communities, and the nature and extent of the ties connecting people and communities and public institutions. Better understanding of how this synergy between social capital and local policy can be strengthened is crucial to minimize natural resource management conflicts.

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Enhanced learning from multi-stakeholder partnerships: Lessons from the Enabling Rural Innovation in Africa programme

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Abstract

Despite increasing interest and support for multi-stakeholder partnerships, empirical applications of participatory evaluation approaches to enhance learning from partnerships are either uncommon or undocumented. This paper draws lessons on the use of participatory self-reflective approaches that facilitate structured learning on processes and outcomes of partnerships. Such practice is important to building partnerships, because it helps partners understand how they can develop more collaborative and responsive ways of managing partnerships. The paper is based on experience with the Enabling Rural Innovation (ERI) in Africa programme. Results highlight the dynamic process of partnership formation and the key elements that contribute to success. These include: (i) shared vision and complementarity, (ii) consistent support from senior leadership; (iii) evidence of institutional and individual benefits; (iv) investments in human and social capital; (v) joint resources mobilization. However, key challenges require coping with high staff turnover and over-commitment, conflicting personalities and institutional differences, high transaction costs, and sustaining partnerships with the private business sector. The paper suggests that institutionalizing multi-stakeholder partnerships requires participatory reflective practices that help structure and enhance learning, and incrementally help in building the capacity of research and development organisations to partner better and ultimately to innovate.

Published

Natural Resources Forum (2007) **31:**273–285.

National Agricultural Innovation Systems that Work for the poor: Building on the Bolivian[3] experience

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Introduction

The project *Alliance for Andean Change* began in January 2007. It involves Andean partners to diffuse participative approaches and methodologies. Several of these approaches and methods are international public goods, which have been approved, developed and institutionalized by National Agricultural Innovation Systems (NAIS) in Bolivia, Colombia, Equador and Peru. The project's purpose is to improve the alignment of market-led agricultural innovation with poverty reduction by making new agricultural technology more accessible and relevant to the poor through the use of participatory methodologies.

The proposal builds on previous work done in cooperation with the NAIS in Bolivia by three Initiatives funded by the Department for International Development (DfID):

- INNOVA, a consortium of leading R&D organizations in Bolivia, facilitated by the Centro Internacional de la Papa (CIP) that works on participatory market chains and mechanisms to link supply and demand for new technology;
- Fomentando Cambios (FOCAM), a project managed by CIAT that works on participatory monitoring and evaluation; and
- The FIT Program that manages a portfolio of strategic projects designed to influence policy and build capacity in the NAIS to achieve pro-poor impact.

The project's regional activities with the Andean countries are built around their common problems with respect to the marginalization of small producers, especially indigenous people, in contrasting agro-ecological zones. All four countries have highland *sierra* and lowland *amazonia* agro-ecologies where R&D for innovation among small producers is especially complex. All are experimenting with decentralized, participatory approaches and policies that enable rural innovation for marginalized people. South-South learning with a regional focus will be an important feature of the project that will build on the ongoing partnerships that the CGIAR Participatory Research and Gender Analyis (PRGA) FIT, CIP and CIAT have with national research programs and existing networks in the Andean countries.

The Outputs of the project are the following

- A set of successful and appropriate participatory methodologies and approaches that favour local development and improved livelihoods for the rural poor are consolidated and widely disseminated in the Andean region through knowledge-sharing among the NAIS of Bolivia, Colombia, Ecuador and Peru.
- Evidence of effectiveness of participatory, local development and livelihood methodologies used to inform pro-poor policy change in four Andean national systems.

[3] Project for 4 years, financed by DFID and executed by The International Center for Tropical Agriculture, CIAT and Centro International de la Papa, CIP.

- A proven organizational model linking research with evidence-based agricultural and rural policy formulation that favours the poor tested in one NAIS and providing lessons for South-South knowledge sharing in the Andean region.
- Participatory methodologies, which constitute international public goods to be shared and improved with partners in the Andean region.
- A practical, proven approach for South-South knowledge sharing is developed and validated with four countries in the Andean Region.

Achievements

Thematic Groups Creation

Since this is a Programme with a wide coverage and several partners, the team created the following:

- An International Steering Committee: composed of representatives of the international centers, the regional coordinators and a political liaison for each country.
- An Executive Committee composed of the international center representatives and the regional programme coordinator.
- Thematic Areas: Methods, agro-negocios, knowledge interchanges and impact.

Thematic Areas

The project executive committee created four thematic areas, which coordinate effort to achieve the objectives and proposed results for the program. Each thematic area is composed of regional partners and national teams that support and coordinate the activities in each region. The thematic areas and their components are the following:

- **Methods Thematic Area:** Led by CIAT and the regional Coordinator of the Andean research consortium. In Bolivia it works with producers' associations, the PROINPA foundation, CIAT-Santa Cruz, PRODII and R-CAD, in Peru with INIA, with INIAP and the Randi Randi Foundation in Equador with the PBA Corporation and the Federación Nacional de Cafeteros in Colombia and is involved as well with Latin Potato network.
- **Agro-Negocios Thematic Area:** Led by CIP and the regional Coordinator of the Red Papa Andina. It works with the PROINPA Foundation and producers' associations in Bolivia, INIAP, IDTG and producers' associations in Perú, with INIAP and the Marco Foundation in Equador and with the PBA Corporation and producers' associations in Colombia.
- **Knowledge Interchange Thematic Area:** Led and coordinated by CIAT and recently with the COLNODO team as a regional partner for information and communication technologies.
- **Impact Thematic Area:** Lead by CIP and coordinated by PREVAL with special support from the Universidad Mayor de San Simón in Bolivia, their IESE Project and qualified regional consultants.
- **Political Thematic Area:** In this area we are identifying a political consultant and we already have political advisors in each country.

Participative Methodologies Inventory:

One of the main achievements of the Program has been to document, in all four countries, 70 approaches and participative methods that are currently in use. These approaches and methods

are posted on the website www.cambioandino.net where visitors can consult the information although the page is still under construction. The idea is to create a searchable database to which other methods, whether from the region or not, can be added and be available for interested users.

Impact Research

There are many impact studies, but few of them focus on the achievements and impacts of participatory methods. For this reason, the program seeks to identify some important participatory experiments where the central theme is the importance of including the poor in the technical innovation process. With these criteria we are developing research to investigate approaches and the impact of applied methodologies and obtain the relevant data to document and transfer this information to decision makers for political impact.

We have started four studies using participatory methodologies. Two of the studies are in Bolivia. The first is in Chuquisaca, where we established a participatory system for monitoring and evaluation (S&EP for its acronym in Spanish) for technological development with the association of producers of chili and Padilla peanut (APAJIMPA). The second is in Candelaria, where we are using participatory methodology in production chains (EPCP for its acronym in Spanish). In Peru we are researching the Marenas project in Colombia we are working with the Ñame producers association on the Atlantic Coast.

We already produced maps for the original and current partners, impact pathways, semi-structured structured surveys, and focused interviews. The research is currently being analyzed and the final documents will be available by the mid 2008.

Participative Implementation Methods

Once the available methodology was documented, we moved on to assess the demand for methodologies by regional and national projects. We identified the following criteria:: coverage, dimension, type of participatory farmer, agro-ecological region, relevance to the donor and others that supplied more detailed information with regards to the importance of the project and its relevance to the program.

Out of a total of 47 projects in 2007, 14 were selected in the four countries. These will apply the 7 methodologies identified by demand. These proposals will be implemented in 2008.

Lessons Learned

- Many methodologies and projects failed because they did not take into account active participation of the end users or producers in the process. For this reason, we require a better understanding of the methodologies to obtain active participation of the end users of the technology in the decision making processes.
- There are some examples of participatory research in the Andean region, but they are very dispersed. The main objective therefore is to document, inventory and systematize the available information. This will allow it to be publicized more successfully with regards to including the poor the processes of technological innovation.
- The involvement of participatory methodologies in the innovation processes have not been evaluated properly nor has the approach or its impact been researched. For this reason, we required special research that shows their contribution to these processes.

- With the objective of obtaining resources to implement projects, we created several producers' organizations, but they are too weak to enforce their regulations and achieve their objectives. For this reason, they require organizational strengthening to carry out their functions and start to participate actively in the processes of technological innovation.
- Communities and producers' organizations in areas of povertydo not have procedures nor training on production chains. and they have even less connections with markets. For these reasons they are not able to evaluate the alternatives to improve their resources. The need is to strengthen their capacity to involve local partners that allows them to develop opportunities to improve their incomes.

Entry points for research to improve agricultural-based livelihoods in Central Africa: Insights from party numbers

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Abstract

The Consortium for Improving Agriculture-based Livelihoods in Central Africa (CIALCA) is a recent initiative that seeks to maximize synergies amongst three international agricultural research centres and their national research and development partners in order to enhance farm-level impacts of their different but related projects in Rwanda, Burundi and the Democratic Republic of Congo. As an entry points into rural communities, CIALCA conducted a number of participatory rural appraisals (PRAs) with over 2500 male and female farmers in 46 communities in their mandate area. These PRAs were based on the sustainable livelihood framework and applied "party numbers" or numbers derived from participatory methodologies that provided some quantification of relevant aspects amenable to statistical analysis. These PRAs were conducted to establish research priorities and identify researchable issues, constraints, opportunities, and develop realistic action plans for rebuilding agricultural research for development in the context of post-conflict societies. This paper discusses agricultural-based livelihoods in CIALCA mandate areas and suggests strategic entry points for rebuilding research for development capacity in the region. Four strategic entry points are suggested: technology push, market orientation, capacity strengthening, and innovation platforms for achieving impact at scale. Although still in its infancy, CIALCA has been proven to work, and holds considerable potential for enhancing collaboration and partnerships, mobilizing resources; and enhancing scientific capacities for improving agricultural-based livelihoods in the medium-to-long term. The results of PRAs informed the selection of action sites, further characterization of mandate areas, design and sampling for baseline studies, and the selection of possible entry points for research and development interventions.

Fostering pro-poor governance of natural resources: I. Participatory bylaws reforms in Uganda

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Abstract

This paper reflects on experiences of five-year participatory policy learning and action research (PLAR) project that aimed at strengthening local-level capacities to develop and formalize by-laws for effective natural resources management (NRM) and governance. The PLAR involved a top-bottom-up iterative process of social learning and experience sharing, policy dialogue and negotiation, and adaptive management that resulted in the formulation and formalization of a set of bylaws regulating soil erosion control, tree planting, animal grazing, bush burning, and wetland management. This paper describes the participatory bylaw reform process, and analyses the mechanisms for bylaw formalization and enforcement. This experience suggests that with appropriate catalyzation, rural communities have capacities to develop their institutions, skills and networks for participatory NRM governance. A subsequent paper discusses the results of a post-project tracking study on the outcomes and the conditions for sustainability and uptake potential of community bylaws reforms.

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Fostering pro-poor governance of natural resources: II. Tracking outcomes of participatory by-law reforms in Uganda

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Abstract

In this paper we use empirical evidence from a tracking study to investigate the outcomes and potential impacts of a five-year participatory learning and action research (PLAR) project that aimed at strengthening the capacity of local communities to formulate and implement by-laws for sustainable natural resource management (NRM). Results based on participatory self reflective practices, revealed changes in seven key outcome areas: awareness and compliance with the by-laws, participation in mutually beneficial collective action, changes in gender dynamics, connectedness and networking, adoption of NRM technologies, sustainability and potential uptake of by-laws. The paper highlights some downside of community by-laws and the challenges in dealing with social exclusion and inequity. Scaling-up participatory processes, particularly influencing national-level policies, remains an important challenge for research, development and policy.

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The dynamics of social capital in influencing use of soil management options in the Chinyanja Triangle of Southern Africa

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Abstract

Farmer groups and farmer organizations have in the recent past become an important vehicle for community development. For research and development organizations, they provide a cost effective and efficient way to reach smallholder farmers with interventions and development programs. For smallholder farmers, they the generate social capital necessary for them to have a voice and bargaining power especially when used for collective marketing or collective management of natural resources. While literature on social capital and the role it plays in technology adoption, farmer empowerment and marketing abounds, there is not much on the role of social capital in influencing the use of options for soil fertility management. Where it does exist, the literature equates membership in groups to social capital. This paper analyses the role of social capital in influencing the use of soil fertility management technologies by smallholder farmers in the Chinyanja triangle of Malawi, Zambia and Mozambique. It uses factor analyses to develop classes of social capital and analyzes how each of these capitals influences the use of the technologies. Results show that both bonding and network (bridging) social capitals influence technology use. Gender was also important in that women were more likely to adopt technologies that saved them labor or increased the production of crops under their control.

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Using spatial analysis for targeting research and scaling-up opportunities

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Abstract

Geographical Information Systems (GIS) maps showing the prevalence and/or location of a certain feature, e.g. poverty rates, soil type, or rainfall distribution are common and these have evolved to predict/target where a similar environment or production system might occur, e.g. programs such as Homologue, Floramap. This paper reports the use of GIS to characterize the sub-Saharan African Challenge Program's southern Africa Pilot Learning site (PLS), and to identify project research sites that represent the variability across the PLS (250,000 km^2 across north-eastern Zimbabwe, central Mozambique and central Malawi). Initial variables were agro-ecosystem potential, population density, livestock density, time to input/output markets and poverty index. Time to markets was calculated using a model that takes into account road location and quality, as well as land-cover classes and constraints to movement, like slope. By further classifying the variables into low, medium and high, a domain-development matrix was developed that reflected the project's objectives. Selection of sites for the 2007-8 season and for implementation of the research program were based on these derived development domains. This paper presents the results of a participatory diagnosis process that integrated the socio-economic variables into delineation of the development domains. A scaling-up approach, which uses this methodology to target research and extension approaches across the PLS and into the wider geographical region, is presented. Linking this approach to other tools, like the use of Near Infra-Red Spectroscopy for analysis of soil and plant productivity, or CaNaSTA (Crop Niche Selection in Tropical Agriculture) is discussed.

Published

Bationo, A., Okeyo, J.M., Waswa, B.S., Mapfumo, P., Maina, F. and Kihara, J. (eds.) *Innovations as Key to the Green Revolution is Africa: Exporing the Scientific Facts Abstracts, 2007*. P. 235. URL:
http://www.ciat.cgiar.org/tsbf_institute/pdf/afnet_symposium_2007_abstracts.pdf

Forming a community of practice to strengthen the capacities of learning and knowledge sharing centers in Latin America and the Caribbean: A D-group case study

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Abstract

This paper presents a case study of work carried out to facilitate the creation of a community of practice, using D-groups (an on-line resource to foster groups in international development) and taking advantage of this virtual space to apply a qualitative monitoring technique called 'most significant change'. Through the D-group we attempted to facilitate knowledge sharing and communication flow among 14 learning and knowledge sharing centers of Latin America and the Caribbean. The year of work evidenced that to create a community of practices it is not enough to have a common and free virtual space and technical support and on-line facilitation. Factors such as connectivity, experience in using virtual tools, personal interests, influence of gender on participation, and decision making play a key role in determining the success of a community of practice. A major lesson learned was that a community of practice is an initiative that must build on its membership and not outsiders who only are taking into account some issues, one side of the situation and not the whole context.

Understanding how participatory approaches strengthen innovation systems

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Abstract

Adapting through innovation is one way for rural communities to sustain and improve their livelihoods and environments, but only if they are able to evaluate actual and potential innovations. Since the 1980s, research and development organizations have developed participatory approaches to foster rural innovation. This paper develops a model, called the Learning-to-Innovate (LTI) model, of four basic processes required for an innovation system to work, and that participatory approaches can influence. The processes are: Creating awareness of new opportunities; Deciding to adopt; Adapting and changing practice; and, Learning and selecting. The model is then used to analyze four of CIAT's participatory approaches to evaluate the model through the quality of insights generated. The approaches are Farmer Research Groups (CIALs, the acronym in Spanish), the Territorial Approach, Rural Planning and Learning Alliances. The analysis shows that, while outwardly very different, the four approaches are built from combinations of eleven strategies. Most of these strategies are aimed at providing information about new opportunities and deciding to adopt, and give less support to the latter two processes, thus suggesting one way the four participatory approaches can be strengthened. Missing from all four approaches are tools to allow people to evaluate the sustainability of likely social, economic and environmental changes resulting from innovation. Beyond analyzing participatory approaches, the model could be used as a framework for diagnosing the health of local innovation systems and designing tailor-made approaches to strengthen them.

Using community indicators for evaluating research and development programmes: experiences from Malawi

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Abstract

Evaluations involving stakeholders include collaborative evaluation, participatory evaluation, development evaluation, and empowerment evaluation, distinguished by the degree and depth of involvement of local stakeholders or program participants in the evaluation process. In community participatory monitoring and evaluation (PM&E), communities agree on the program's objectives and develop local indicators for tracking and evaluating change. PM&E is not without limitations, one being that community indicators are highly specific and localized, which limits wide application of common community indicators for evaluating programs that span social and geographic space. We developed community indicators with six farming communities in Malawi to evaluate a community development project. To apply the indicators across the six communities, we aggregated them, and used a Likert scale and scores to assess communities' perception of the extent to which the project had achieved its objectives. We analyzed the data using a comparison of means to compare indicators across communities and by gender.

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Participatory monitoring and evaluation: Integrating community perspectives in PM&E for improved performance, decision making and accountability

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Abstract

Over the last few years, there has been a major focus on extending the use of monitoring and evaluation beyond their accountability functions to include program improvement, for learning and change. Such utilization-focused evaluations do not advocate any particular evaluation content, model, method, theory, or even use. Rather it is a process for making decisions about these issues in collaboration with an identified group of primary users. Participatory monitoring and evaluation (PM&E) offers new ways for involving different stakeholders in the monitoring and evaluation process including local communities and for strengthening institutional and community learning and change.

One of the key challenges of these utilization-focused and participatory M&E systems has been to ensure that different stakeholders are effectively engaged in the process. More often than not, local stakeholders are relegated to the role of providing information for monitoring and evaluation with very limited or no involvement in the strategic stages of the process such as making decisions on what should be monitored and contributing to the monitoring and evaluation indicators. Intended users are more likely to use evaluation findings if they understand and feel ownership of the evaluation process and findings, and if they are actively involved. The involvement of uses in the M&E process has also led to an expansion of the role of monitoring and evaluation from an accountability function to include program improvement, decision making, planning, organizational learning and change.

This paper gives a practical methodological process and sequence of key implementation steps that can be use to involve stakeholders, especially communities, in the design and implementation a project monitoring and evaluation system. It gives the details of the capacity-building process required for the key stakeholders, the involvement of communities in designing the key areas for monitoring and evaluation, in developing indicators and in data collection and analysis. The paper gives an example of the use of the methodology in Kenya, which was aimed at effectively engaging local stakeholders, especially communities, in project-level monitoring and evaluation and specifically in deciding what should be monitored, the development of indicators and data collection and analysis. A few of the results of the process are outlined including the differences in evaluation areas and indicators between the researchers and the communities and the learning change process within the institution.

The paper analyses the results of the process in terms of the internal changes arising from it and the extent to which it contributed to making the monitoring and evaluation more relevant to local stakeholders. It demonstrates the use of the PM&E results by communities for improved decision

making, learning and ensuring accountability by R&D institutions. The paper also gives some suggestions and strategies on how participatory monitoring and evaluation can be institutionalized in research and development organizations, the tools and methods used and the changes both in enriching the PM&E process with local perspectives and the internal learning and change processes that take place within the institution as a result of the process.

Published

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Building capacity for monitoring and evaluation: integrating stakeholders perspectives in participatory monitoring and evaluation within R&D systems

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Abstract

In the last few decades, there has been a substantial growth in the use of participatory approaches in research and development. For years, research and development organizations applied participatory approaches in the planning and implementation of research and development programs and yet reverted to traditional and conventional means in evaluation. The situation is slowly changing with the current impetus for participatory evaluation. One of the reasons is the concern that when program implementers or users of evaluation results are not involved in the evaluation, there is limited use of evaluation results for program improvement and for organizational learning and change. There is recognition however that involving program staff and stakeholders is necessary but not sufficient to promote use of evaluation. Another growing focus is the different elements or types of use including process use. There is recognition that use must be supported by evaluation capacity building so that the skills and knowledge from participation in evaluation are translated into changes in the way individuals and organization work. The concept of 'participation' is broadened to move beyond program staff to include communities and other stakeholders involved in the implementation of programs and projects. This paper describes the process of a collaborative action research oriented participatory monitoring and evaluation between the Kenya Agricultural Research Institute and the International Centre for Tropical Agriculture. It focuses on the capacity building in evaluation skills, integration of other stakeholders, in facilitation skills and attitudes for self evaluation. The outcomes of this process in terms of consequences of integrating different stakeholders, evaluation capacity at individual and collective level and organizational changes are described. Most of these outcomes are not from the use of evaluation findings from specific programs but result from the involvement of program participants, communities and other stakeholders in the monitoring and evaluation process itself and the accompanying capacity development.

Published

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Developing internal monitoring and evaluations systems for program improvement, organizational, community learning and change

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Abstract

This paper describes a process of developing an internal monitoring and evaluation within an agricultural research organization. The paper uses three case study projects from the Kenya Agricultural Research Institute working on adaptive research. The paper provides a conceptual framework for distinguishing monitoring and evaluation as well as community and project level M&E. The community and project M&E were applied variably across the three projects and an analysis was made of the outcomes. The paper analyzes the role of interlinking the project and community level M&E in bringing stakeholder perspectives into M&E, increasing community decision making and organization, organizational learning and change, improving project implementation and empowering stakeholders. The challenges of developing internal M&E systems in agricultural research and development are also discussed.

Published

Accepted by the *American Journal of Evaluation.*

Impact evaluation in the Challenge Program on Water and Food: A report to the CPWF Steering Committee

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Introduction

This report gives a brief overview of progress and status of Impact Evaluation in the CPWF, in particular with respect to recommendations from the recent External Review.

Impact evaluation (*ex-ante*, M&E and *ex-post*) in the CPWF is handled by two projects and the CP Secretariat:

- The BFP-Impact Project that began in October 2005 and works on impact pathways, extrapolation domain analysis and scenario analysis;
- The Adoption and Cost Benefit Analysis Project that began in July 2007; and
- M&E (for accountability) is managed by the Secretariat.

BFP-Impact Project

The CPWF External Review (ER) found value in the impact pathways, extrapolation domain analysis (EDA) and scenario analysis work. Figure 1 was useful in explaining to the panel the relationship between CPWF projects themselves and the Basin Focal Projects (BFPs).

Advances in the last year include:

- Impact pathways were constructed for the first call projects in the Yellow River and Limpopo Basins. Impact pathways have been constructed for 8 out the 9 basins (the Nile remains to be done).
- Adoption of Participatory Impact Pathways Analysis (PIPA, the approach used to develop project impact pathways) by CIP's Impact Enhancement Division, a Gates-funded project in Africa, the ILAC Initiative (managed by Bioversity) and the EULACIAS Project (EU-funded, managed by Wageningen University working with universities in Mexico, Uruguay and Argentina).
- The inclusion of PIPA as a method to support *ex-post* impact assessment (by generating impact hypotheses) in the forthcoming SPIA publication: *Strategic Guidelines for Ex-Post Impact Assessment of Agricultural Research.*
- A journal article on PIPA was accepted by the *Journal of Program Evaluation*.
- A journal article was prepared on EDA and scenario analysis methods, using PN16 – Aerobic Rice as the worked example

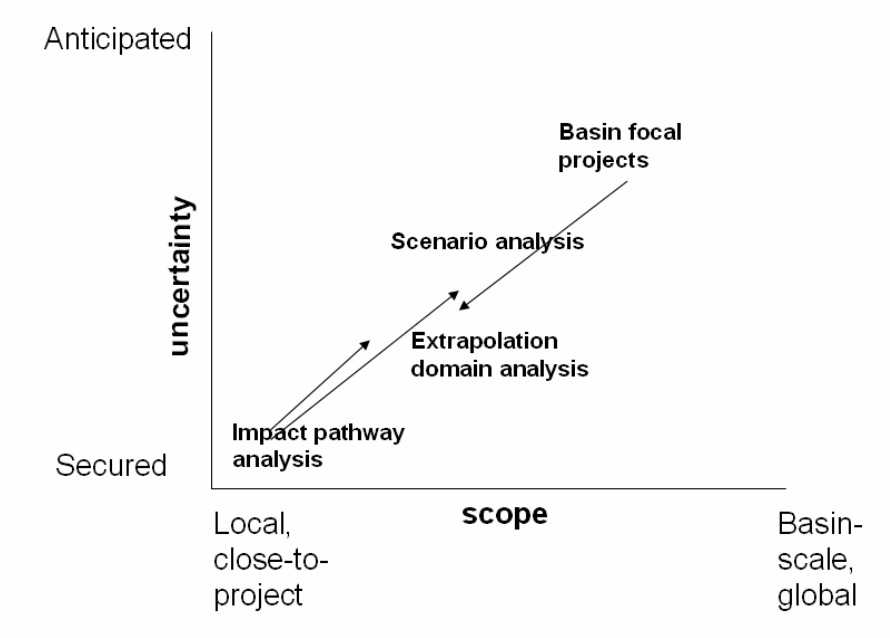

Figure 1. How impact pathways analysis, extrapolation domain analysis, scenario analysis and the Basin Focal Projects fit together.

- The team working on EDA is developing promising methodology that allows country-level socio-economic data to be geographically distributed at sub-country level. The approach has much broader applicability than the CPWF.
- The development of an on-line resource on impact pathways. In January 2008, 5.2 Gb of information was processed in 661 page views by 317 users, predominantly from the USA.
- We are working with Dr. Abigail Barr, an applied econometrician from University of Oxford to help us analyze network data coming from projects' construction of their impact pathways. This will allow us to characterize and contrast the relationships that the CPWF is building through the research it funds. For example, we will be able to examine whether the CPWF is brokering links between food and water organizations.

The ER saw impact pathways analysis as laying the foundations for full social cost-benefit analysis. It acknowledged that: "The estimation of costs and benefits associated with research initiatives is by no means straightforward. The exercise in itself is currently a research issue" (p. 58).

Adoption and Cost Benefit Analysis Project

The ER acknowledged that the "Adoption and Cost Benefit Analysis Project" was generally in-line with its recommendations. We have acted on their suggestion to re-examine the project's goals so as to "catalyze more tangible research results" by cutting the part they did not like and putting more resources towards the part that they did like.

The Adoption and Cost Benefit Analysis Project began as a recommendation from the CPWF's Steering Committee (CSC) to carry out impact assessment to establish "hard evidence of impact". Last year, in approving the project, the CSC recommended that the study should fulfill both an internal programmatic learning purpose and an external 'accountability' function.

Firstly we noted that as CPWF projects have been going only 3 to 4 years, and as research to full impact can take 20 years or more, we decided to use a mixed method approach in which formal cost-benefit analysis is a component (mixed method approaches are recommended as good practice by the Network of Networks on Impact Evaluation (NONIE) when dealing with complex projects and programmes).

We devised the following approach:

a) Identification of important project-level changes by asking (30+) project leaders to describe the most important changes achieved by their projects.
b) Selection of the most important of these by Theme Leaders and the Program Leader (i.e., the CPWF's scientific leadership).
c) We used the Most Significant Change (MSC) Approach for 1 and 2, www.mande.co.uk/docs/MSCGuide.pdf).
d) As a result we selected five changes to evaluate, from five projects. The projects selected were:
    - PN10 - Coastal Resource Management for Improving Livelihoods;
    - PN16 - Aerobic Rice;
    - PN20 -: Sustaining inclusive Collective Action that Links across Economic and Ecological Scales in Upper Watersheds;
    - PN28 - Multiple Use Systems;
    - PN47 - African Models of Transboundary Governance (in particular the impact of the database of African Water Treaties);.

We are now in the process of designing an evaluation for each of the five changes including the contracting of external evaluators who will work with the respective theme leader, as co-evaluator, and the respective project leader will adapt and refine a common set of evaluation questions.

Some key features of this approach are:

- We are evaluating our bright spots to provide hard evidence of success and learn from them.
- The twin objectives of programmatic learning and external validity comes from using an internal program and external evaluator in each case.
- We deliberately have a positive bias in our survey. We are taking an innovation perspective in our evaluation that acknowledges that "with innovation one invariably succeeds via the small number of exceptions, and usually after a series of failures."[4] We want to capture those exceptions.
- Quantitative cost-benefit analysis will be carried out where it is sensible to do so. The project is not mandating any specific method; that will be up to the external evaluator and the context and will be part of our method development.
- In this way the project is a response the ER's recommendation that the CPWF contribute to the research issue of how to estimate costs and benefits associated with research initiatives.

Monitoring and Evaluation

A meeting of key CPWF staff in January 2008 developed an internal M&E system, based on impact pathways, which will link activities to program objectives through the use of logical

[4] Perrin, B. (2002). How to - and how not to - evaluate innovation. *Evaluation* **8:**13-28.

frameworks at project, basin and program level, and thus complying with an ER recommendation. The system will meet both programmatic learning and accountability requirements.

The Institutional Knowledge Sharing Project: A project of the Information and Communications Tecnologies – Knowledge Management (ICT-KM) program of the CGIAR

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Introduction

The 15 CGIAR Centers and their many national partners are together creating a wealth of knowledge that can help rural communities in developing countries build sustainable livelihoods. While all players are doing much to ensure this knowledge is widely shared, formidable obstacles to its uptake and use, and, ultimately, the impact of CGIAR agricultural research, remain. One of the missing elements, the appropriate and effective sharing of knowledge, both within Centers and between them and their partners, has reduced the effectiveness of CGIAR research and development (R&D) efforts.

The overall goal of the project is to improve CGIAR effectiveness through knowledge sharing (KS) principles, tools, and methods. KS principles are based on participatory approaches, joint learning and action research-based approaches. By tools, we mean web-based software (i.e. collaborative platforms, Web 2.0 tools like wikis, blogs, etc.). By methods, we mean group processes that people can use to interact with each other (Open Space Tecnology, After Action Reviews, Knowledge Fairs, Peer Assists, etc.).

The project is divided in two sub-projects: KS in Research (KsinR), led by IWMI and the Institutional KS Project (IKS), led by CIAT. The project addresses the issue of how agroecosystems retain resilience in the face of climate change, water- and soil-related stresses and other major threats, in the sense that itIt seeks to improve the conceptual and empirical understanding of how impact occurs, and how this understanding is used by researchers and development agencies to design more effective interventions. Through three major components, the IKS project aims to design more effective interventions in the areas of collaboration, communication, and knowledge management.

Component One

The project seeks support and engagement from top CGIAR management by responding to concrete needs that have been expressed at the System level. IKS participated actively with the CSO-CGIAR engagement initiative. Initial collaboration with the CGIAR Secretariat on virtual dialogues, on-line surveys, and the inception workshop of the Grant Scheme Program clearly showed the adoption of IKS principles and methods. The inception workshop of the winning projects provided new ideas related to communication, M&E and joint learning activities among projects, and a concept note for further activities is being drafted by IKS. Both IKS and KsinR will continue to support this activity to support the CGIAR efforts to improve partnerships with civil society organizations specifically through the next years CSO Forum at AGM08. Apart from the Secretariat, this activity involves both the Science Council and important donors.

IKS was actively involved with the preparation of the Science Forum of AGM07. IKS contributed to these preparations by designing on-line surveys and formulating different concepts

and proposals to achieve the inclusion of KS-friendly approaches, which were only very partially adopted. Hence impact was rather less than hoped for.

The expected outcome is an alliance of CGIAR members, partners and the IARCs that are strengthened by the use of IKS tools and methods. A further opportunity to be explored is the involvement in the CGIAR Change Management Process underway in 2008.

Component Two

This component addresses the need for institutional change within the CGIAR by expanding the first phase of the IKS project to address broader Center management-related issues. Pilot initiatives in CIFOR, Worldfish, and IRRI/CIMMYT are related to data management, strategic planning, research communication and marketing.

An inception workshop was held at IRRI HQ on August 21-23. Impact Pathways were chosen as a project planning methodology. Apart from some misfits between the objectives of the pilot initiatives and the overall objectives of IKS, the pilot projects are expected to deliver as expected given that they are all well defined and planned. The leaders are committed to their task and the areas covered are strategic for promoting KS work in the CGIAR. The idea of a "write shop" suggested by KSinR as an end-of-the-project activity that would combine evaluation, reporting and communication gives a useful term as well as the possibility to explore effective marketing of the pilot project activities.

The expected outcome of this component is that KS principles and approaches are applied in projects that deal with the management of organizational change in selected centers, with the experiences shared and documented. Special effort will be needed to share them widely to generate interest for adoption and replication.

Component Three

The third component of IKS is dedicated to a continuous effort to strengthen KS capacity. Good progress has been made towards meeting this objective. A Knowledge Sharing workshop has been designed and announced. Additionally there has been the launch of a call for abstracts for evaluation, documenting, and sharing of innovative web-based collaborative experiences within the CGIAR and its partners. Joint activities with the KM4Dev community continue and building links with other CGIAR programs have been explored. The KS toolbox, a web-based selection of KS processes, in the initial stages of being further developed with a consultant and the concept for the development finalized. The KS website has experienced an increasing number of visitors and visits during the year.

Communication efforts

IKS interacted with the other projects of the ICT-KM Program. It fostered communication with the CGIAR Secretariat and Centers (mainly IRRI, WorldFish, ICRAF, ICARDA, CIFOR, CIAT, CIMMYT) and with other System-wide Programs (PRGA, G&D) and with the Science Council. Interaction with KM/KS practitioners through KM4Dev and outside of development organizations helped to enrich the concepts and developments of project activities. We interacted with members of the CSO community and its CGIAR partner organizations.

IKS used its blog to share insights and reflections regularly. We improved and updated the project Web site constantly; we promoted the use of the project wiki, published a blog and leaflet for the KS workshop, and contributed to the publication of the KS booklet.

ICT-KM Program and Project teamwork

IKS is committed to the goals and mission of both the project and the ICT-KM program as a whole. The project is proceeding as scheduled, with satisfactory interactions and collaboration between both the ICT-KM Program coordination and the KSinR project. IKS also received feedback from Program management that it needs to broaden its client base beyond those who are already convinced of KS. This is a challenge for the second and final year of the project.

Reducing water treatment costs to invest in conservation: Are the savings enough to benefit upland catchments and people?

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Removing sediments in water costs money. The savings generated by reducing the costs of treating water for human consumption can cover a part of the costs of conserving watersheds. The cost share depends on the relative costs of: treating water and conserving land to avoid erosion.

CIAT conducted research:

(1) To obtain an economic estimate of "water quality" ecosystem services provided by the Chingaza water system of the Empresa de Acueducto y Alcantarillado de Bogotá (EAAB);

(2) To estimate the value of "water quality services" to compensate farmers and generate incentives to conserve natural areas and implement good land and water management practices;

(3) To generate a cost-effective methodology for future studies in Colombia; and

(4) To develop a publishable scientific document of the study and its results.

The case study is an area of paramo. The National Natural Park (PNN) of Chingaza is 50km to the east of the Bogotá and provides approximately 70% of the city's water. The study basin, of the Rio Frio - Rio La Playa (of 91. km^2), is inside the PNN Chingaza (766 km^2), which is a protected area. Chingaza is one of three water supply systems of EAAB; the other two are Rio Bogotá and Tunjuelo (Figure 1).

To determine the feasibility of making conservation investments with savings generated by reducing sediments, the study addressed four key areas of research:

- Biophysical;
- Socioeconomic;
- Institutional; and
- Financial.

In addition, the study extrapolated the results and findings to another catchment of the EAAB, the Tunjuelo system.

- The biophysical analysis (climate, water, soils) used two quantitative models: SWAT (Soil and Water Assessment Tool) and FIESTA (Fog Interception for the Enhancement of Streamflow in Tropical Areas).

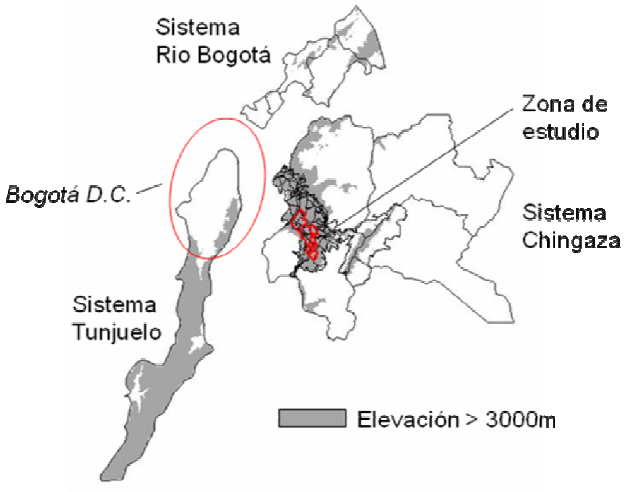

Figure 1. location of the study area.

- The socio-economic analyses (farm profits, costs of externalities) employed the quantitative model ECOSAUT (Environmental, Social, and Economic Evaluation of Land Uses).
- The institutional analysis examined "the rules of game" such as the laws and policies regarding the current use and the use rights of natural resources. In spite of formal rules, many local practices and informal traditions prevail. To understand the context and history of Chingaza, we interviewed farmers who live next to the park. Their preferences for ways to pay for their land stewardship were analyzed using a methodology that permits comparison of subjective data (Analytical Hierarchy Process, AHP).
- The financial analyses benefited from inputs from EAAB and the Nature Conservancy. The analyses addressed both sides of the services market: (a) urban willingness to pay (arising from savings from treating less sediment), and (b) rural willingness to accept compensation (the opportunity costs of not realizing agricultural activities, or of the costs in establishing conservation measures that diminish soil erosion).

In addition, the CIAT team reviewed the scientific literature, compiled data, implemented quantitative models, interpreted and refined results, discussed the implications with TNC, EAAB, PN and Econometria, and made appropriate adjustments to the analysis. Due to being a pilot effort, the study opted for testing analytic settings based on current and hypothetical situations.

For Chingaza, the costs to treat water are minimal. Waters from the park pass through a reservoir that cleans the sediments. Although future costs arise from reservoir siltation, the financial implications are minimal given its large size and associated number of years (>50) before capacity is affected. Therefore, no possibility of cost savings exists. Nevertheless, possibilities of savings are present in Tunjuelo where the treatment plant presently faces high costs and where the savings could cover up to 12% of the costs of conserving the watershed.

Publication

CIAT (2007). Análisis de oportunidades de inversión en conservación por ahorros en tratamiento de aguas: *Sitio del estudio: El Páramo de Chingaza, Colombia.* CIAT Report. November 2007. 141 pages.

Ecosystem services from improved soil and water management: Creating a return flow from their multiple benefits

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Abstract

Soil and water conservation practices (SWCP) provide multiple onsite and offsite benefits, which can be economically significant, including regulation of the flow of water and sediment, reduced agricultural water demand, storage of carbon in soil, reduced vulnerability to drought and flooding, and higher farm productivity. Payments or other forms of compensation for environmental services (PES) have been directed primarily at forest conservation to protect offsite benefits that are associated with regulation of the flow of soil and water but have been hindered by difficulties of quantifying them, and of assuring potential buyers that they will have access to them in the future. Onsite productivity benefits of SWCP are more demonstrable, can provide greater motivation for adoption, and can play an important role in poverty alleviation. However, adoption still presents institutional challenges and has upfront costs. Therefore, this review suggests that, if PES is to play a critical role in enabling a transition to sustainable rural development, it will be necessary not only to demonstrate the offsite benefits of soil and water conservation practices, but also the onsite benefits, as well as to understand what it will require to motivate farmers to adopt them at a large enough scale to deliver valued services. This will require a better understanding of the local context, beginning with choices that upland communities have for meeting their most immediate needs and for responding to threats to livelihood security, as well as the economic incentives that influence specific land use practices. To the extent that these practices can be connected to offsite impacts, and to broader social benefits, it will be possible to make a stronger case for external support, through various forms of payment arrangements. By starting with the livelihood needs and direct benefits to upstream communities, links to downstream benefits can proceed incrementally as understanding is gained, and as institutions are developed or strengthened in upland areas that enable collaboration at the scale necessary to deliver benefits. This approach also provides those downstream with a greater opportunity to learn about connections between these services and their well-being, and to reconsider the values placed on them. It may also then be possible to make payments contingent on service delivery.

Published

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CIAT. Impact of participatory NRMR in cassava-based cropping systems in Vietnam and Thailand

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Abstract

Between 1994 and 2003, the Asia regional office of the International Center for Tropical Agriculture (CIAT), in collaboration with national agricultural research partners in Thailand, Vietnam, Indonesia and China, implemented a Nippon Foundation funded project titled "Improving the Sustainability of Cassava-based Cropping Systems in Asia." The goal of the project was to increase the living standard of small farmers and to improve agricultural sustainability in less favored areas of Asia by improving the productivity and stability of farming systems where cassava is an important crop. Although prior research had identified many potential soil conservation and fertility management options with potential for use in these cassava systems, there were not being adopted by farmers. Therefore the CIAT project was designed with a dual focus of developing technologies and the same time ensuring their adoption and effective use. This was to be accomplished by using a farmer participatory research (FPR) approach in which farmers themselves were involved in identifying, testing and promoting promising technologies.

The objective of this paper is to assess the impact of the CIAT project. This involves assessing both adoption and impacts of the project technologies as well as the contribution of the participatory approach. Few studies attempt to distinguish between these two different types of impacts, however it is important to do so. A growing share of scare research and development resources are being spent on participatory methods, however it appears that decisions about use of such methods are often based on personal experience and conviction rather than on solid evidence of their relative contribution to impact. This study is forms part of a growing effort to document and measure the impact of participatory methods in natural resource management (NRM) research.

This chapter is organized as follows: section two discusses some conceptual issues related to assessing the *ex post* impacts of farmer participatory cropping systems research. Section three describes trends in cassava production in Asia and explains the main features and outcomes of the CIAT project. Section four presents the farm-level impacts of participation and adoption of new technologies. Section five identifies institutional impacts of the project, and the final section provides some conclusions.

Published

Waibel, H. and Zilberman, D. (eds.) *International Research on Natural Resource Management: Advances in Impact Assessment* (2007) Oxford University Press: New York. 320pp. [A previous version was published as Working Paper #23 of the Participatory Research and Gender Analysis

(PRGA) Program; summary available as Standing Panel on Impact Assessment (SPIA) Brief #15].

Participatory evaluation of green manure legumes

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Rationale

An effective strategy of forage technology improvement addresses the production constraints in the target areas, incorporates participatory research to generate adoption of the proposed technology and offers new technologies to the intended users for further adaptation and innovation. A technology with forage legumes as green manure, when generated by conventional means, is not likely to solve farmer and livestock problems unless combined with other approaches like farmer participation. Thus, in this study we integrated soil fertility management and (multipurpose) forage legumes with participatory tools. The green manure project was supported by developing techniques for participatory evaluation and for capacity building.

The problem of the hillsides in Colombia is that the production systems are vulnerable to degradation due to erosion on steep slopes and loss of soil fertility. We hypothesized that it is possible to enhance the stability of agricultural production in the hillsides through improved animal systems, based on improved forages, to produce meat and milk. The approach used was farmers and researchers working together to identify forage germplasm options. Forages are versatile and can be used in different ways in the complex production systems of the tropics. Most forages, and particularly legumes, have direct effects on crop production including weed suppression, pest and disease reduction, and indirect effects through their use as green manures, improved fallows, cover crops, and live barriers.

Background

A technology with forage legumes as green manure, when generated by conventional means, is likely not going to solve farmer and livestock problems unless combined with other approaches like farmer participation. For the participatory procedure to be successful, the following basic principles need to be observed: Firstly, participatory research is a broad term referring to development approaches, which should have active farmer participation in all stages of the development process. Secondly, a culture of mutual accountability should be established between farmers and scientists. Thirdly, effective communication mechanisms among different actors (farmer to farmer, between farmer and scientist) are essential.

Overall strategy (steps of the participatory procedure)

Phase 1: Motivation of farmers to participate (2006). The participatory tool used was a flowchart technique in order to visualize steps and time required. Using a flowchart the facilitator explained to farmers the research objective. Based on this, farmers and scientists decided what (i.e., changes in soil and crop conditions due to green manure options), how (i.e., through yields and biomass production of subsequent crops) and when to evaluate. The following forage options were tested as green manure: Lablab (*Lablab purpureus* CIAT 22759), cowpea (*Vigna unguiculata* CIAT 9611) canavalia (*Canavalia brasiliensis* CIAT 17009)and fallow ("rastrojo") as a local control.

Phase 2: Participatory evaluation of green manure legumes (2006). The objective was to assess farmers' preferences for green manure species using a combination of preference ranking and open evaluation methods. Results indicated that in the assessment made by farmers, cover was the most important criterion across the four green manure species. Foliage was the next in importance, followed by pest tolerance, germination, growth, color, flowering, precocity, and production. A regression analysis showed that there were diverse ranges of acceptance and rejection in relation to the green manure options. Fallow as the local control was consistently rated as having low acceptance; cowpea and lablab had high acceptance, and canavalia had an intermediate acceptance, probably due to a 2-3 week time difference for this species' plant maturity in comparison with the other legumes.

Phase 3: **Participatory evaluation of green manure legumes (2007).** The remainder of this report refers to the evaluation phase of the project in 2007 in which the information in phase 2 is compared with evaluations at the time of harvest of the subsequent crop (maize) that was sown on the green manure plots in March 2007.

Methodology

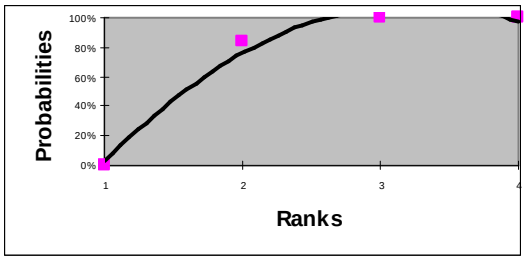
A participatory evaluation was conducted on 20 January 2007 at the El Rosal farm, in the municipality of Caldono, Cauca, to assess the effect of crops of green manure species on a subsequent maize crop. We used preference ranking and open evaluation methods with a total of 9 farmers (6 males and 3 females) from the village of Pescador. The information was gathered via participatory discussions in three groups of 3 farmers together with a facilitator/ technician.

We recorded the farmers' spontaneous responses regarding their criteria in evaluating the maize plots. We then used multivariate analysis to identify the criteria that the farmers thought were important.

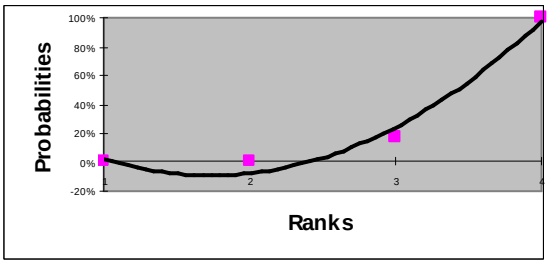
Results

The farmers assessed, in order, high grain yield, short plants, robust (thicker) stems and darker green leaf color as the most important criteria in evaluating the effect of green manure on the subsequent maize crop. Judged on these criteria, *Vigna unguiculata* CIAT 9611 and *Canavalia brasiliensis* CIAT 17009 were the superior legumes for green manure. The farmers chose grain yield and color as measures of plant vigour and plant height and stem diameter as measures of plant stability (resistance to lodging).

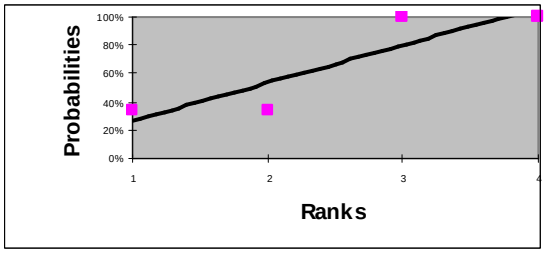
Regression analysis revealed diverse ranges of acceptance and rejection in relation to the green manure effect on the maize crop (Figure 1). *Canavalia* had the highest acceptance followed by cowpea. Lablab had intermediate acceptance. The high level of acceptance of *Canavalia* probably is due to biomass volume reached by this species (plant maturity reached after 2-3 months). Fallow alone *(rastrojo)* had little effect on the subsequent maize crop and so was consistently ranked last.



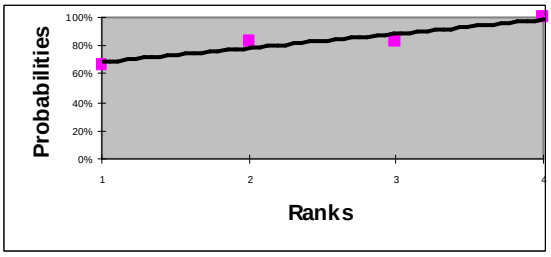
Lablab



Fallow



Cowpea



Canavalia

Figure 1. Acceptance tendencies of three green manure legumes and fallow depending on the effect in maize.

Concl usions

- A successful participatory procedure for evaluating forage legumes for green manure has been developed.
- Capacity building that links on-station and participatory research has been established.
- Grain yield, plant height, stem diameter and leaf color (from high to less importance respectively) were the most important criteria by which farmers evaluate the effect of legumes as green manure for maize;
- Canavalia had the highest acceptance followed by cowpea. Lablab had intermediate acceptance, while fallow *(rastrojo)* was consistently ranked last;. and
- Creating a critical mass of scientists and development partners is crucial for scaling up the participatory procedure (strengthening human and social capital).

Output 2. Market value chain management practices

Introduction

Almost everywhere smallholder farmers are seeking to generate income from increased productivity. This gives them new opportunities as a result of growing demand from domestic urban populations, or from new or more accessible export and niche markets. Opportunities can be in existing staple crops, or in high value commodities such as fruit. While the emphasis varies by region, we need to assess opportunities in the context of changing market needs, expected impact on farms and rural enterprises of the poor, and both market and non-market failures.

Although market access is key to widespread alleviation of poverty, its characteristics are different for domestic and export markets; for supermarket chains; and niche versus traditional export commodities. Many factors can determine the bargaining power of smallholders, including the quantity, quality and competitiveness of their supply, and the confidence in their reliability held by those further along the value chain. Wholesalers, processors, transporters, retailers and consumers all manage by their own criteria. A key research question is how to build and sustain customer support for products that promote development. Effectively answering this question requires cues from simple businesses that work very well. This research agenda responds directly to System Priority 5B, and integrates some work formerly undertaken by CIAT's *Spatial and Economic Analysis for Decision and Policy Support* and *Rural Agroenterprise Development* Projects.

In Central America, a learning alliance carried out targeted action research that responds to specific knowledge gaps identified with key partners. Our emphasis has been on cyclic learning with higher order partners such as international NGOs under the assumption that these organizations are better suited to generate large-scale systemic shifts. However, each of those international partners works with their own networks of local partner agencies, thus leveraging change in a network of more than 60 organizations working with large numbers of farm families. Knowledge about the functioning of the learning alliance is an important output that is being evaluated and adapted to local circumstances in southeast Asia and East Africa, and is already being widely applied by others.

An analysis of trends in the agrifood system of Central America shows how changes are transmitted from rural communities to urban consumers along integrated supply chains managed by increasingly powerful food retailers. The survival of individual farmers and farmer associations lies in their capacity to participate in these dynamic systems, in part by focusing on consistent volumes of product that meets quality and food safety. This is more difficult for poorer farmers to accomplish. We conclude that governments must not overlook the need to take policy decisions that support the move from a supply chain to a more integrated value chain focus and that serve to increase the competitive position of a chain. A detailed examination of the functioning and sustainability of a French bean value chain from Guatemalan smallholders to USA retail outlets suggests that their production for a set market under clearly established terms leads to substantial risk reduction and explains why even truly poor families can avail themselves of this opportunity.

We also examined fertilizer use in southern Africa as an agricultural input that we might expect to be encouraged by better market access for the harvested product. While this was generally borne out by the study, membership of groups was also an important determinant, as these

farmers were able to pool their resources for bulk purchase. More surprisingly, access to subsidized fertilizer was not associated with increased rates of use, in part because many of those farmers had a strong incentive to sell their subsidized fertilizer for a higher price to farmers in a neighboring country, which had no such scheme.

International commodity trade implications for biofortification

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Introduction

Harvested crops can be consumed on-farm or traded, a factor that can have important effects on the impact of biofortification. While food consumed on-farm has a short pathway from field to the table, marketed food crops end up in many different places and can be transformed in different ways. Prolonged food storage and transport can lead to micronutrient degradation due to changes caused by light, heat, and moisture.

The key trade and food aid problem for biofortication is ensuring that micronutrient-dense foods reach people who are poor and malnourished. Biofortified crops can easily be exported to countries and populations that are not the intended beneficiaries. Malnourished populations in a country could be consuming imported foods, diluting the share of micronutrients from biofortified foods that are locally produced.

How might international trade and food aid impact on biofortication strategies? Which countries and which crops are subject to these problems? We considered these questions by assessing international trade of key HarvestPlus crops. Utilizing FAO data sets, we studied production, imports, exports and food aid to get a sense of international trade implications for biofortification strategies.

Our analysis uses food balance data to assess crop production, imports, exports, consumption and food aid. Countries are classified according to the level of imports and exports and are organized according to per capita trade. The general framework of the classification is shown Table 1, including the potential trade impacts on biofortitication.

Table 1. Framework for assessing implication of trade and food aid on biofortification.

	Low imports	High imports
Low exports	Ideal situation: low import consumption reduces likelihood that local (biofortified) production is diluted; less concern about biofortified food leaving country as export.	Much of the consumed crop comes from other countries, mixing with local biofortified varieties. The non-biofortified imports, instead of local biofortified crops, may reach malnourished people.
High exports	Biofortified production may leave country as exports; biofortified exports could help other countries.	Important to know where the imports go to; and to know the source of the exports (are they exporting biofortified varieties?)

Our data source is the FAOSTAT web site. The data are averages of three years, 2000, 2001 and 2002. These years are more reliable than the three latest years because they have been retroactively updated and verified. A three-year data set smoothes out data anomalies that one would find in a single year. Developed countries were excluded from this analysis.

Summary of Results

An aggregate view of crop production shows that, import and export trade of the six principal HarvestPlus crops is less than 25 percent of the domestic supply (Table 2). There are substantial imports of maize and wheat with 17 and 24 percent, respectively, of the supply imported, compared with less than 8% for rice, beans and cassava. With beans, 15% of the value of domestic supply is exported. There is little international trade in sweet potato.

Table 2. Production, imports, exports and domestic supply of 6 HarvestPlus crops in 122 developing countries of Asia, Africa and Latin America.

	maize	wheat	rice	beans	cassava	sweet potato
Production (million tons)	270.5	263.8	565.8	15.3	183.0	135.4
Imports (million tons)	51.3	78.7	24.8	1.2	8.9	0.0
Exports (million tons)	22.1	19.9	31.8	2.2	15.3	0.1
domestic supply (million tons)	305.3	324.2	555.4	14.5	174.9	135.4
% imports of domestic supply	16.8	24.3	4.5	8.0	5.1	0.0
% exports of domestic supply	7.2	6.1	5.7	15.1	8.7	0.0

An analysis of each HarvestPlus crop was made to assess trade implications for biofortification., We give our analysis of maize below as an example.

International trade in maize has potentially negative implications for biofortification in in several countries (Figure 1). Most maize on the international market comes from the United States, while Argentina exports two-thirds and Paraguay one-third, of their total maize production. Apart from

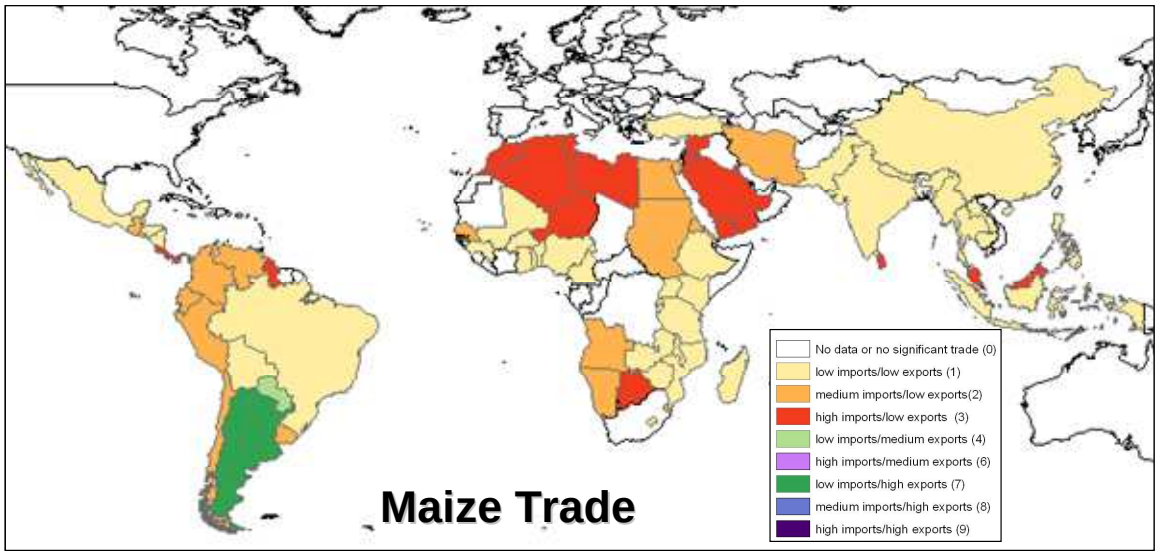

Figure 1. Imports and exports of maize as a percentage of domestic supply.

them there is scant export from other developing countries. so that exports will have little effecton domestic consumption of biofortified grain.

In contrast, imported maize could dilute the supply of biofortified maize in a substantial number of countries. There are 27 countries, shown in red in Figure 1, and mostly in the Middle East and

North Africa, with high levels of imports. Because their domestic production of maize is so low, they are unlikely candidates for biofortification. However, they could potentially receive biofortified maize from exporting countries.

A group of 18 Latin American and African countries, shown in orange in Figure 1, import more than one-third of their maize supply but also have substantial domestic production. The malnourished populations in these countries could consume imported maize, raising the risk that locally-produced micronutrient-dense varieties may not reach the target beneficiaries of biofortification..

Discussion and conclusions

Global and national biofortification strategies should consider levels of international trade and food aid when making research and development investment decisions. Across 13 crops and 122 countries, in only 6% of those with substantial domestic production were imports greater than 33% of the domestic supply. That is to say, if all 13 crops in all 122 countries were to be biofortified, on average there could be a problem for each crop in about seven countries, obviously a different group of countries for each crop.

Biofortified crops may not reach domestic populations because a large proportion of the crop is exported. Rice in Thailand and Pakistan, cassava in Thailand, and beans in Bolivia are the main examples. Biofortification of bananas would likely face trade problems because countries with substantial crops are also large exporters. Data on wheat were not available for the Central Asia countries, where both production and exports are substantial. China, Brazil and India are large wheat producers but export little.

Imported food competing with locally biofortified foods is a potential problem for biofortification, especially in the case of the three most important crops for international trade, wheat, maize and rice.

An Integrated Research-for-Development Project in Laos

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Introduction

The five reports that follow are part of a joint research-for-development (R4D) project between CIAT and the University of Natural Resources and Applied Life Sciences (BOKU), Vienna, Austria *Spatial Trade-off Analyses for Site-sensitive Development*. The project has completed its second year with important advances with respect to the three R4D themes of: (1) spatial analysis of changing natural resource endowments; (2) participatory market chain analysis; and (3) collaborative livelihood analysis and opportunity identification support. Links to other projects and development organizations, both government and non-government, continue to deepen and broaden.

Research financed by Austrian Development Agency, the project completed its 3rd year.

Women's views on paper mulberry in Lao PDR: Local knowledge, perceived potentials

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Abstract

The research aims to shed light on the role of gender issues in the domestication and increased commercialization of paper mulberry bark in Oudomxay. The villages studied currently undergo a transition from a subsistence economy to a market economy, which may affect household livelihood strategies and intra-family decision making. Through increased commercialization, domesticated paper mulberry will generate cash income that can contribute to alleviate poverty. The success of commercialization depends on how domestication fits into individual livelihood strategies. Knowledge, access and control of resources as well as control of the cash income from paper mulberry bark are differently shared between men and women. Therefore the first objective is to document the division of labour in harvesting, processing and selling the bark from both wild and domesticated paper mulberry, as well as clarifying who controls which resources related to the commercialization of paper mulberry bark. The second objective is to consider the traditional knowledge about paper mulberry, as well as its uses and its role in the family livelihood. Finally the fears and hopes of women related to the domestication and increased commercialization of paper mulberry will be assessed. Through this research women's strategic and practical needs will be clarified. These insights can help governmental agencies, NGO´s and relevant institutions to design an intervention strategy leading to an efficient supply chain for high quality paper mulberry bark.

Publication

MSc Thesis (BOKU), 2007.

Rural livelihood strategies and natural resources in Oudomxay, Lao PDR

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Abstract

Rural communities in Lao PDR are highly dependent on their natural resources such as timber and non-timber forest products, and agricultural land, for cash income and subsistence. Approximately 80% of the Lao PDR population lives in rural areas where the incident rate of poverty is 40%. Oudomxay, in the northeast of Laos, is the second poorest province in the country. It is a rugged, mountainous region, with a largely rural population. Due to a variety of factors such as population growth, opening up of the economy, forest degradation and implementation of government policies in agrarian reform, the livelihoods of rural people and their access to natural resources are being altered. Within this setting, a livelihood strategy analysis was conducted in Mang village, Oudomxay focusing on specific livelihoods and specific natural resources. The interrelations between changing access to specific natural resources and rural livelihood strategies of villagers within different wealth categories and different genders were studied.

This research was conducted within the sustainable livelihoods framework. Participatory Rural Appraisal (PRA) techniques such as, time trend analyses, focus groups, and semi-structured interviews were utilized to reach the objectives of the study. Results show important changes in livelihood strategies and associated land uses over the last 10 years. The cultivation of upland rice and the raising of livestock, although still important, have decreased; while strategies such as the cultivation of lowland rice, sesame and maize have increased. Other strategies have also become important, such as the cultivation of puak muak, paper mulberry (posa) and rubber trees. The density of puak muak and posa trees have decreased within the forest but have increased in domesticated plots. There are adoption disparities of certain livelihood strategies between wealth categories. For example, the richest people tend to cultivate more lowland rice and were the first to adopt this strategy. In addition, access to certain natural resources also differs between wealth categories. For example, the majority of the richest people's agricultural land is located closer to the village than that of the other wealth categories. Changes in access to natural resources have also occurred such as land is acquired differently due to the implementation of land allocation polices enforced by national and local governments. To address the priorities and capacities of families within different wealth categories, targeted development interventions are required that support livelihood transitions.

It is anticipated that this assessment of rural livelihoods will support rural communities and extension staff in Oudomxay in determining positive development options more effectively. This study is part of the CIAT-BOKU Research for Development Project 'Spatial trade-off analyses for site-sensitive development', which is working in collaboration with the provincial Oudomxay Community Initiative Support Project (OCISP) and IFAD.

Publication

MSc Thesis (BOKU), 2007.

Analysis of fallow system development in Laos using historical satellite images

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Abstract

For more than 400 years the Khmu, one of the oldest ethnic groups of Oudomxay province, Northern Laos coexisted in relative harmony with their environment. Rapid population growth in the last 50 years has been the main cause for the abandonment of a sustainable fallow management practice. Other factors included: state policies to intensify agriculture and to discourage the use of slash-and-burn cultivation, wilderness areas given over to protected sites and the selling of large tracts of land for rubber tree plantations. The aim of this research is to develop a methodology that can identify the pattern and magnitude of spatial and temporal changes of land-cover using remote sensing techniques. Particular attention is given to the distribution of fallow-age classes, frequency of slash-and-burn events, and areas of intensive agricultural production. The definition of land-cover classes in this research is based on the reflectance characteristics of the land-cover types in the spectral bands registered by the Landsat7 ETM+ sensor.

Unsupervised classification of a multi-temporal Normalised Difference Vegetation Index (NDVI) data set was used to analyze the land-cover changes between three dates of imagery. This method uses a technique to visualize change in land-cover using multi-temporal NDVI imagery and interpretation concepts of colour additive theory. Comparing on a category-by-category basis the relationship between known ground reference data from field work and the corresponding results of the unsupervised classification, it was possible to carry out an accuracy assessment of the classification. One outcome from the development of a methodological approach to identify change in landcover in the province of Oudomxay was the production of a thematic map indicating levels of land pressure.

Low pressure areas were found in the less populated and inaccessible mountainous regions of Oudomxay. High pressure areas were found in the wider and low-lying valleys where large populations have settled and where there is good infrastructure with major rivers and roads providing links to the provincial and international markets.

Publication

MSc Thesis (BOKU), 2007.

Multi-stakeholder processes to improve a non-timber forest product supply chain in Lao PDR

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Abstract

The main research question is, what factors affect commercialization of paper mulberry bark in Lao PDR? I describe a case study that uses the supply chain as unit of analysis to address this problem.

The factors found in this case are compared using two models: 1) Homma's model of extraction economies; and 2) A new institutional economic model. Homma's model (1992) assumes that markets of non-timber forest products (NTFPs) are perfect and that demand for NTFPs is perfectly elastic. This model has shown some potential to understand the trade of forest products as it can predict dynamics related to internationally traded NTFPs (Neumann and Hirsh 2001).It is often implicitly used for analyzing supply chains (Te Velde *et al.* 2006). A recent, second model on the commercialization of NTFPs takes its concepts from new institutional economics that reject the assumption of perfect information, zero transaction costs and full rationality of the supply chain stakeholders. Instead it makes the assumption that stakeholders are self-seeking individuals who attempt to maximize their desired outcomes constrained by a bounded rationality. I conclude that both models alone are incomplete alone, but if merged they are powerful predictors of the factors observed as affecting the supply chain of paper mulberry bark.

Objective 1: To understand under which conditions desired outcomes of the supply chain of paper mulberry bark can be reached, that is, the factors in the perception of the stakeholders of the supply chain, which affect the functioning of the supply chain so that desired outcomes can be reached.

Expectation 1: There are incentives to cultivate paper mulberry bark and that pro-market institutions, information asymmetries, relations of trust, vertical and horizontal coordination are influencing its commercialization.

This first objective leads us to a second objective, which is to define desired outcomes, that is to improve the functioning of the supply chain. As this thesis takes constructivism as its paradigm (in which realities are socially constructed) I believe improvement can only be brought about by the stakeholders of the supply chain themselves.

Objective 2: To understand what the stakeholders of the supply chain themselves define as the goals that they want to reach with increased commercialization of paper mulberry bark.

Expectation 2: Stakeholders of the supply chain define improvement of the supply chain as higher economic benefits for supply chain participants, together with protection of natural resources and equitable growth for stakeholders of the supply chain. This conceptualization is consistent with most of the literature, which argues that sustainable growth is the desired outcomes of commercialization of NTFP (Figure 1).

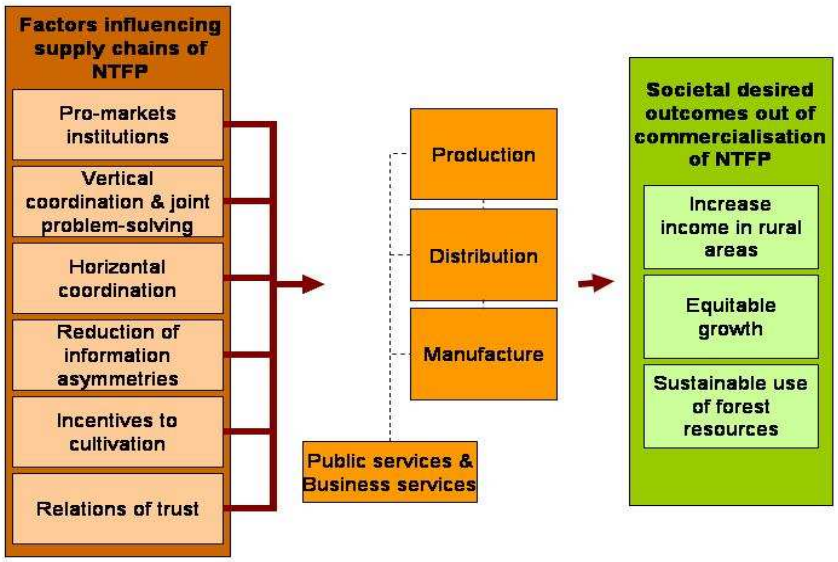

Figure 1. Factors affecting supply chains of NTFP and societal desired outcomes of the commercialization of NTFP

This conceptualization raises the question, what is the effect of a participatory supply-chain analysis on the factors themselves? This question leads to the third objective.

Objective 3: To understand better the potential of the participatory tool of supply-chain analysis to bring about change in the factors that affect the supply chain.

Expectation 3: Multi-stakeholder processes to analyze the supply chain have a positive effect on the factors that affect the supply chain through deeper understanding by the participants of how the supply chain works.

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Publication

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Refining a collaborative livelihood system appraisal and development approach in Laos

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Summary

The Collaborative Livelihood System Appraisal and Development (CLSAD) approach has been designed to enable extension staff and farmers to work together in the identification and development of different livelihood opportunities in complex and diverse environments. Rather than the commonly-practiced problem-based approach, the CLSAD approach emphasizes success-based development. Participants are guided by extension staff through the process of exploring past successes and then building on these successes to identify and achieve future goals. The CLSAD approach is divided into the following 5 phases:

Step 1: Recognizing past strengths

Farmers are guided to search for examples of past successes.

Step 2: Envisioning future goals

Based on the past achievements, farmers identify future visions and realistic livelihood goals.

Step 3: Designing action plans

Farmers identify what livelihood strategies are necessary in order to reach their livelihood goals.

Step 4: Implementing action plans

Farmers organize themselves in order to implement action plans collectively.

Step 5: Participatory monitoring and evaluation

Farmers develop and run their own monitoring and evaluation system, which allows them to track the changes in their livelihood over time.

We emphasize that farmers are actively involved in each of the phases in the CLSAD approach.

Publication

Draft Extension manual. BOKU. 2007

Learning Alliances in Central America

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Introduction

Millions of dollars are spent each year on research and development (R&D) initiatives to improve rural livelihoods in the developing world. Despite this expenditure, rural poverty remains an intractable problem in many places. Among the multiple causes of this situation is the limited collective learning that occurs between researchers, development workers, donors, policy makers and private enterprise. As a result, useful research does not benefit the poor, lessons learnt do not influence research, donor and policy agendas are less relevant than they could be, and development falters. In response to this situation, a series of actors came together in 2003 to build a learning platform, called a learning alliance, to address these issues with particular emphasis on processes of rural enterprise development in Latin America.

The learning alliance evolved in a context characterized by global shifts in funding for R&D initiatives, serious problems of inequity and persistent levels of rural poverty and important shifts in development strategies and the regional trade context. Throughout the end of the 1990s and early part of the 21st century, funding for research and development initiatives have shifted increasingly towards Africa and Asia with the remaining funds concentrated in a relatively few countries in Latin America such as Haiti, Bolivia, Honduras and Nicaragua. Despite four to five decades of investment in R&D focused on poverty reduction and economic development, Latin America remains a region characterized by exclusionary development patterns and, in particular, a bias towards urban and industrial development at the expense of rural populations and agriculture in general. The combination of reductions in funding and seemingly intractable problems led to two important shifts: (a) a growing focus on diverse collaborative processes and trying to do more with fewer resources; and, (b) the rapid development of market linkage programs to leverage rural development through improved links to the private sector and modern national and international markets.

The negotiation and approval of Free Trade Agreements in Central America and the ascendance of the theme of 'making markets work for the poor' have only served to deepen these trends. A key indicator of this shift can be found in the increasing number of public policies focused on increasing rural competitiveness through supply chain interventions. What started as a policy innovation in Colombia more than 10 years ago is now one of the most common public policies in terms of rural economic development in the region. This has served to promote more market-oriented approaches in rural development and re-orient public spending in this direction.

The Learning Alliance

As a result of these contextual conditions, many organizations were receptive to the idea of moving beyond independent interventions to explore the possibility of more effective work through collaboration and shared learning. In 2003, a group of international development NGOs (Catholic Relief Services, GTZ, CARE, Swisscontact), Research and Teaching Institutions (the National Agricultural University of Honduras and, CIAT) and donors (IDRC) formed a learning alliance with the objective of promoting collective learning in the theme of rural enterprise development. Emphasis to date has been on higher order partners (e.g. international NGOs

instead of local NGOs) under the assumption that these are better suited to generate large-scale systemic shifts. However, each of the aforementioned international partners works with their own networks of local partner agencies thus leveraging change in a network of more than 60 organizations working with an estimated 125,000 farm families.

The learning alliance seeks to identify, innovate and disseminate effective practices related to rural enterprise among the partner agencies and to specific external groups including policy makers, donors and relevant private sector firms. The alliance seeks to engage partners in processes of double-loop learning, inviting participants to reflect on their underlying assumptions, identify knowledge gaps, co-develop innovative prototype approaches, methods and tools, test these in diverse contexts and reflect collectively about what works where, with whom and why. Specific topics have included the identification and development of opportunities to link smallholder farmers and diverse markets, supply chain analysis and upgrading, the provision of sustainable technical and financial services, in supply chains and in rural areas, product and process innovation among multiple actors and knowledge management for rural enterprise development.

Based on the principles and the goal of the learning alliance, implementation focused on four interrelated strategies. These include capacity development of partner agencies, targeted action research to resolve specific issues, connectivity and knowledge management and policy incidence. Capacity development activities seek to strengthen or improve partner capacities in the use and adaptation of specific approaches, methods and tools. This process is directly linked to specific learning cycles as described below. Capacity building occurs through training workshops and, more importantly, field level backstopping during partner implementation and adaptation of the prototype. Targeted action research responds to specific knowledge gaps identified with partner agencies. In this strategy, key research questions are identified and fieldwork designed and implemented in collaboration between CIAT and partner agencies. Outcomes and findings are shared with other partner agencies in workshops and in electronic formats. Connectivity and knowledge management strives to increase the density of relationships that form the basis of the learning alliance. The 'densification' of networks and personal connections is critical to the success of the alliance. To achieve this, the alliance makes use of face to face meetings, training and exchange visits as well as virtual tools such as a website and a list server[5]. A final strategy focuses on incidence vis a vis key decision makers in partner organizations, public sector entities, donor agencies and private sector firms. This strategy has been markedly less successful than the previous three in engaging non-partners. Despite this difficulty, the learning alliance partners still feel that this is a critical capacity that should be developed to leverage higher-level change based on field results.

At a more practical level, the learning alliance has selected specific learning topics. For each topic selected, the alliance has implemented a learning cycle as shown in Graphic 1. The learning cycle seeks to facilitate a logical process of exploration and innovation common across topics and partner agencies and thus draw out more robust lessons at the end of the process. In practice, however, certain steps were compressed or skipped where deemed useful by partner agencies. Outcomes have been most visible in the area of improved practice and empirical evidence for theory development. A major challenge in using the learning model is the demand

[5] . See www.alianzasdeaprendizaje.org

for process and product documentation, especially by development agency field staff who already feel overwhelmed by project reporting responsibilities.

Within this framework, diverse partners play different roles at different times in the process. First, all partners participated actively in setting the agenda for the learning alliance. At times this led to long discussions and debates but in the end has increased the ownership of the alliance as such. The downside of this process is the possible dilution of research questions, in the strict sense, towards more action-research. While this may be detrimental for publications, the ownership benefits seem to outweigh the pure scientific contribution of the alliance. Second, much of the learning process was handled by research agencies, in this case principally CIAT. This was due partially to a perceived comparative advantage in process documentation but also the prevailing culture where researchers write while development agencies do. Finally, the relative weakness in disseminating results at a higher level limits the reach of this work. Difficulties in this area are ascribed principally to a lack of experience in turning research and development results into policy instruments.

The development of the learning alliance has permitted new patterns of interaction to emerge among partner agencies. At the outset of the alliance, most partners approached the process with the question of "what's in it for me and my agency". As connections between partners deepened, this attitude has shifted to one of increasing openness and willingness to share experiences, methods, tools and develop joint proposals. A key indicator of this change is the provision of peer assists between partner agencies where a more experienced practitioner will provide insights and support to newer entrants in the field. In addition, alliance members report easy access to other partner agencies via e-mail, phone calls and field visits. This has proved especially difficult to document as a project outcome but is highly valued by participants.

Results

The benefits obtained from the learning alliance can be seen at different scales: (a) individual beneficiaries such as small farmers and their families; (b) supply chains and their associated actors; and, (c) partner organizations as such. In the case of individuals, benefits include increased sales and reduced risk through the use of participatory methods to identify and respond to market opportunities.

At the supply chain scale, CARE Guatemala adapted the supply chain analysis and upgrading methods provided through the learning alliance to work on cardamom and honey. As a result their support shifted from production oriented to one of market development and value addition for high quality products. This has led in turn to higher income for producer organizations and increased demand for new associations. CRS Nicaragua made use of supply chain analysis to negotiate and support more favorable commercial agreements for 229 small bean producers with an export firm. Despite serious problems with drought and low average yield, this agreement led to US$49,000 in additional sales in 2006 with both producers and the export firm living up to their agreements. Based on this experience they will continue to work together. Finally, Swisscontact Honduras reports greater knowledge of the fresh vegetable sector, leverage with supermarkets and connections with the Ministry of Agricultural and Livestock program on supply chain development in Honduras as a result of action research projects carried out with the alliance. As a result they are better positioned to link fruit and vegetable producer associations to dynamic markets and leverage both public and private sector support for these initiatives.

In addition to specific benefits obtained at the individual or collective level, the learning alliance also provides benefits to partner organizations through networking. Oxfam Great Britain highlights links developed through the alliance to work with the Rural Development Institute of Nicaragua to develop commercial contacts between small-scale farmer associations in Nicaragua and the markets in El Salvador and diverse support received from CRS El Salvador, the José Matías Delgado University of El Salvador and Swisscontact Honduras for an ambitious 15-year scale-up initiative in Western Honduras. Likewise, CRS and CARE Guatemala report rewarding processes of cross learning and collaboration facilitated between previously closed agencies by the alliance. This has allowed both agencies to work with other partners and develop more strategic programs. Finally, CIAT as such has benefited from increased networking to identify key topics for new research, development of specific project proposals and the articulation of existing research to a larger audience of potential innovators. This permits the Center greater reach at a lower cost and thus contributes to increased leverage of research for development.

Lessons learned

Several important lessons can be extracted from the learning alliance for innovation systems work. First, the critical importance of connecting and engaging individual people in a transparent fashion with sufficient information and under the aegis of an honest broker to build trust. Our experience highlights the importance of individuals as opposed to organizations as well as the need to avoid organizational standard bearers who feel threatened by open systems where 'the competition' also participates. Second, clear and shared objectives, applicable results, personal commitment and flexibility are key elements. An effective innovation system adds value to individual participants in diverse ways by leveraging a collective motivation to work smarter. Finally, the facilitation of an innovation system is an art in itself. The learning alliance has taught us to value diversity of opinion and tension as a crucible of creative ideas.

In the hopes of contributing to more effective innovation systems in the future, there are also several critical issues and/or errors that can be taken from the learning alliances. These include: (a) the difficulty of selling a process in a project and outcome driven context; (b) a lack of causality in many of the results which makes evaluation and reporting difficult in more formal channels; (c) an initial excessive emphasis on shiny, web-based tools when what seems to work best is face to face exchanges to build trust and innovation; (d) on-going funding for what is, admittedly, a fuzzy, demand-driven process; (e) the need to proactively involve more members of the overall food system (e.g. public policy makers, private sector) from the outset; and, (f) the need for buy-in from key decision makers in the organizational 'home' of the innovation system.

Linking small farmers to high-value and growing markets in Vietnam: The experience of SADU project

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Introduction

In 2007, SADU Project (Small-Scale Agro-Enterprise Development in the Uplands of Vietnam) consolidated its work in several value chains with a view to create a minimal critical mass for scaled impacts. Much progress has also been achieved in the mainstreaming of marketing extension tools at the district and national levels.

These achievements provide a sound basis for scaling-up outcomes and impacts during the two-year project extension (2008-2009) and for documenting and disseminating lessons amongst the global community of development researchers and practitioners. In addition, the project is now in a position to publish the marketing extension guides developed for the Vietnam context and to make them available to an international audience.

Cassava starch value chain, Krong Bong district, Dak Lak province

In 2007 SADU worked with a local starch factory to develop more efficient and more effective contract farming arrangements with its 1,700 contract farmers. As a result of this work, the factory has implemented a series of measures aimed at improving the design and implementation of contracts:

- Contract procedures have been simplified, leading to a reduction in the transaction costs for both the company and the farmers;
- Harvesting calendars are no imposed unilaterally by the factory, but instead discussed with farmers;
- Payment procedures have been changed, with farmers no longer having to travel to the factory to collect payment;
- The relationship between the factory and traders has improved remarkably, with staff being much more cooperative during the collection of fresh roots and the processing of payments;
- For the first time, the factory has signed supply contracts with traders in Krong Bong. This new vertical coordination model has much potential to reduce marketing costs, waiting times at the factory, and product losses;
- The factory is developing plans to establish ten farmer groups as part of a new strategy to promote adoption of improved farming practices; and
- Finally, for the first time, the factory has participated in the establishment of farm demonstrations aimed at exposing farmers to sustainable cultivation models.

The work of SADU in the starch value chain will generate important lessons for other starch factories in Vietnam, and elsewhere, that have or are planning to develop a contractual relationship with suppliers. In 2008 special attention will be given to the development of appropriate, long season contracts as a strategy to address existing constraints in accessing fresh root supplies during the off-season months.

Dry cassava value chain, Krong Bong district, Dak Lak province

An opportunity to improve the profitability of dry cassava processing enterprises in Krong Bong by mechanising the cassava slicing process has been identified. Mechanical slicing reduces labour costs, shortens the processing cycle, and lowers the risk of product losses due to rain. Thinner (and better dried) chips can also be stored for a longer period, which will become an important source of competitive advantage when the large cassava ethanol plants in Vietnam, currently under construction, come into production.

In early 2007, SADU worked with a local workshop and processors to test mechanical slicing technologies. Two local workshops have since started manufacturing a motorised slicing machine, which has so far been purchased by seven small processing enterprises. SADU Project will now focus on assessing the impact of this technology on firm profitability, the demand for fresh roots, and employment as a step towards wider adoption in project areas and beyond.

Cattle value chain, M'Drak district, Dak Lak province

The cattle sub-sector is being targeted for development by the district authorities in M'Drak. Since early 2007 SADU has been working with local stakeholders and experts from Tay Nguyen University to address existing problems in access to feed resources and veterinary services.

In Ea Rieng commune, some 60 farmers have planted forages in an area of about 20 hectares and the district is currently assessing the scope for scaling-up forage cultivation in other communes. Furthermore, the use of enriched rice straw as animal feed has been successfully demonstrated: M'Drak authorities are now promoting this technology across the whole district.

In 2008 SADU will support continued improvements in cattle enterprises and will promote the development of private veterinarian services as a complement to existing government services. SADU will also work with the relevant district and provincial agencies to establish a cattle wholesaling market (if proven appropriate) and to create a more enabling trading environment.

Persimmon value chain, Da Bac district, Hoa Binh province

In 2007 SADU Project continued to implement strategic interventions with a view to develop competitive persimmon cultivation in Da Bac. Through these interventions, the project has been promoting a shift towards *fuyu* – a new, non-astringent variety with very promising marketing potential – and improvements in fruit quality through adoption of good cultivation practices.

Much progress has been achieved in 2007 in re-positioning Da Bac as a competitive supplier of persimmon fruit to urban markets:

- Fifty-five growers have grafted about 550 trees. In addition, about 20 growers have purchased and planted 300 *fuyu* seedlings.
- Two projects have been established by the district Economic Section and the Research Institute of Fruits and Vegetables. Their objective is to test the performance of *fuyu* persimmon under local agro-climatic conditions and to develop a local bank of grafting material. A total of 1,600 seedlings have been planted in nine orchards, in an area of about 3.5 hectares.
- An affordable and environmentally friendly technology for fruit fly control (Ento-Pro) has been successfully tested with the participation of 72 farmers, in an area of about 8 hectares.

Vegetable value chains, Tan Lac district, Hoa Binh province

In 2007 SADU started working with district and commune officers for the delivery of production and marketing advisory services to potential commercial vegetable growers. Potato and chayote were selected as the initial target commodities due to the existing interest of district and provincial agencies.

Some important steps towards the development of commercial and competitive vegetable cultivation have since been taken. First, the district Economic Section has supported the establishment of a vegetable production and marketing cooperative. At the moment, this cooperative has 11 members.

Second, some 70 farmers signed contracts with a potato processing company for potato cultivation in an area of about 20 hectares. It is encouraging to see that the district Economic Section has been playing a very active role in mediating between the farmers and the contracting firm.

Third, following a series of market information collection and sharing exercises, the provincial Science and Application Centre signed contracts with some 100 farmers in five upland communes for piloting chayote cultivation in an area of 3.5 hectares. This activity is funded by Program 135 and the provincial Science Fund. The district Economic Section is now in the process of linking chayote growers with buyers in Hanoi.

In 2008 SADU will work with local agencies to consolidate these initial achievements. Special attention will be paid to enhancing local understanding of vegetable marketing systems, to the development of appropriate district support strategies and interventions, and to the improvement of farmers' technical skills in vegetable cultivation. The new vegetable cooperative in the district will also be targeted for support.

Banana value chain, Aluoi district, Thua Thien Hue province

Collective action can enable ethnic minority banana growers in Aluoi to save labour in marketing activities and earn a price premium by supplying bulk volumes that meet the quality and other requirements of buyers. In late 2007 SADU started facilitating discussions between farmers in selected villages and district traders with a view to assess the feasibility of group marketing. Five farmer groups were then formed to supply bananas on a regular basis to three district traders. In 2008 SADU will continue supporting group marketing and will work closely with group leaders and farmers to improve cultivation and post-harvest practices.

Mainstreaming of marketing extension

SADU has been developing marketing extension tools and a capacity development programme to address current weaknesses in the provision of marketing advisory services to farmers.

The proposed approach has been piloted in Tan Lac district with very good results. At the national level, the College for Managers of Agricultural and Rural Development (CMARD) has started using the materials developed in their courses. Two training courses were also organised in collaboration with the National Agricultural Extension Center (NAEC) and one in collaboration with the Northwest University.

In 2008 two of the four modules of the Marketing Extension Guide will be published and widely disseminated. In addition, continued emphasis will be given to capacity and curriculum

development within CMARD, NAEC, selected universities and development NGOs and projects. Finally, SADU will develop a dialogue with provincial and district decision-makers in project areas with a view to create the financial and institutional conditions for the effective and sustained delivery of marketing extension services at local level.

Participatory Research for Development in the Uplands (PRDU) Project

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Summary

The PRDU project, completing its fourth year of implementation, continued working with national and provincial research partners. The project provides technical and methodological support to four IFAD-funded investment projects, working mostly with ethnic minorities in marginal and mountainous upland areas in south-central China (Guangxi province), northern Laos (Oudomxay province), and northern Viet Nam (Tuyen Quang and Ha Giang provinces).

In 2007, the PRDU project worked with research partners, the IFAD projects' implementing partners (extension agents at the provincial, county, district, and commune/village levels), and farmers to implement field trials aimed at sustainable improvement of livelihoods (increased income and food security) through improved crop and livestock production and increased access to markets. Technical training events were organized for farmers and extension agents. Farmer-to-farmer extension was facilitated through field days at trial harvests. Successful innovations piloted by extension agents and farmers at PRDU "focus villages" are scaled out by extension agents to the wider development project areas.

In remote villages in Oudomxay, Laos, farmers tested higher-yielding cassava and sweetpotato varieties and alternative cropping systems intended to improve sustainability of production on sloping lands. Systems included intercropping with fast-maturing legumes, strip cropping, contour hedgerows and oversowing with legumes for improved dry-season fallow rotations. Variety trials of soybean and open-pollinated maize and crop management trials for stylo *(Stylosanthes guianensis)* were aimed at increasing the quality of locally-grown feeds. Farmers planted kenaf *(Hibiscus cannabinus)* to assess suitability of this potential fibre/feed crop when grown on sloping lands. Training programs on feed formulation and processing and conservation of feeds (drying, ensilage) assisted researchers, students from the regional agriculture college, and farmers in designing and implementing feeding trials for increased village pig production. Training on improved swine management and introduction of improved boars aimed to demonstrate best practices to extension agents and farmers in preparation for the feeding trials. Improved management and feeding practices resulted in significantly faster growth compared to indigenous pig production practices. It also demonstrated the potential for village pig production, using only locally grown feeds, as an alternative livelihood to shifting cultivation of upland rice.

In the mid-height focus communes in Tuyen Quang province and parts of Ha Giang provinces (northern Viet Nam), the project established on-farm trials comparing hybrid and common rice variety and hybrid maize varieties. Farmers in mid-height and highland communes of Ha Giang province who had visited farmers' trials and demonstrations in Tuyen Quang in 2006, implemented species and variety trials of forages for feeding ruminants. They also carried out cassava variety trials and demonstrations of improved cropping systems for growing cassava on sloping lands. Planting materials for scaling-out were multiplied on demonstration trials at new sites.

Maize is the staple food of the Hmong ethnic group in the highland focus commune in Ha Giang province. QP4, an open-pollinated maize variety with high quality protein, was enthusiastically adopted by farmers in 2006 because its yields were substantially higher than the local open-pollinated varieties. The project implemented a demonstration trial in the commune to compare hybrid maize varieties with QP4. Farmers at both mid-height and highland focus communes in Ha Giang planted sweetpotato and taro variety trials and demonstrations.

The project organized farmer field days and demonstrations/training programs for extension agents and farmers at focus communes. For example, in Guangxi province of China, extension agents worked with farmers to implement hybrid maize, cassava, soybean, kenaf, and mulberry (for silkworm production) variety trials They also made cross-community visits to learn about successful use of forage grasses, cassava leaves and starch mill wastes to fatten cattle and about silkworm culture in preparation for production trials.

In late 2007, researchers and extension agent conducted detailed household surveys in each of the project's focus communes in China, Laos, and Viet Nam. The surveys are being analyzed to assess impact of project interventions on key livelihood systems: root crops for food security and feeding pigs (in Laos); cassava for cash income, livestock feeding and food security, hybrid and open-pollinated maize for cash income and food security and forages for feeding ruminants (in Vietnam); cassava for cash income and feeding livestock and forages for fattening ruminants (in China).

PRDU Collaborating Partners

China	Chinese Academy of Tropical Agricultural Science (CATAS)	forages, maize, participatory methods
	Guangxi Subtropical Crops Research Institute (GSCRI)	cassava, participatory methods
Lao PDR	National Agriculture and Forestry Research Institute (NAFRI) • Agricultural Research Center (ARC) • Northern Agriculture and Forestry Research Center (NAFRC) • Livestock Research Center (LRC) • Forest Research Center (FRC, NTFP Unit)	cassava, maize, sweetpotatoes, forages, participatory methods, NTFPs
Viet Nam	Viet Nam Academy of Agricultural Sciences (VAAS) • Food Crops Research Institute (FCRI) • National Maize Research Institute • Hybrid Rice Center • Legumes Research Center • Research Institute for Vegetables and Fruits National Institute for Animal Husbandry (NIAH)	root crops, maize, rice, legumes, baby corn, forages, participatory methods, feed processing
	Thai Nguyen University of Agriculture and Forestry (TUAF)	cassava, maize, fish, participatory methods

Targeted action-research to develop pro-poor private sector policy

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Summary

CIAT research on the French Bean supply chain in Guatemala contributed to the development, improvement and implementation of pro-poor mechanisms by a major US retailer and the dissemination of these results to a group of large-scale buyers of agricultural products globally. This outcome relates to Outcome 3 – Pro-Poor Policy Options for Rural Communities – of the Rural Agro-enterprise Development Project (SN-1) 2007 targets and, specifically, the point on new models in place that link private sector firms with smallholder farmers based on principles of business equity and sustainable NRM. The outcome is documented in a study summary available at http://www.sustainablefoodlab.org/filemanager/download/7767/

This outcome was achieved in the context of a Guatemalan French Bean supply chain that links nearly 2,000 low-income rural producer families to dynamic markets in the US, moves 4.2 million pounds of product a year and generates US $ 1.5 million income for producers. The outcome contributed to the following changes:

1. a decision by the retailer to source its product exclusively from poorer producers and communities;
2. a commitment by the retailer to source additional products (i.e. frozen beans) from the farmer owned cooperative;
3. review of existing business practices on the selection of secondary suppliers; and
4. the establishment of a fund supported by a small percentage of profit from chain actors to reinvest in health care access and educational scholarships for participating smallholder communities and families.

Beyond the chain specific results, this case has contributed to thinking on sustainable relationships between major buyers of agricultural products globally and smallholder suppliers as evidenced by its use at the Healthy Value Chains workshop co-hosted by MIT, World Wildlife Fund and the Sustainability Institute in Boston (August 2007)[6] and the Sustainable Value Chains workshop hosted by the Sustainable Food Laboratory in Guatemala (October 2007) [7]. Companies involved in these learning and discussions spaces purchase over US $ 50 billion of agricultural products annually. They include Unilever, US Foodservice, Costco, CH Robinson, Chiquita, SYSCO, General Mills, Green Mountain Coffee Roasters, Coca Cola, IKEA, BP and Nike among others. The evidence in this paper has contributed to similar work on coffee in Mexico and Central America (with Green Mountain Coffee Roasters), work on shrimp and cashew nuts in Asia and Africa (Costco) and the assessment of tea sourcing (Unilever). Based on this work, CIAT has secured funding through a consortium for US $ 5 million to work on new business models for sustainable trading relationships in Africa.

The principal users of this work are global buyers of major agricultural products. This study contributes to their understanding of how to build pro-poor mechanisms into their supply chains and, as a result, enhances opportunities for millions of smallholders globally directly and

[6] http://www.sustainablefoodlab.org/article/articleview/17942/
[7] http://www.sustainablefoodlab.org/article/articleview/18321/ and http://www.sustainablefoodlab.org/filemanager/download/7425/

indirectly. The study served to initiate dialogues and concrete activities in this direction but is far from the expected final outcome, which is the mainstreaming of sustainable trading practices by businesses globally, and the development of a sustainable food system.

Ex-ante evaluation of the impact of a structural change in fertilizer procurement method in sub-Saharan Africa

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Abstract

In June 2006, the African Heads of State made a declaration to support increase in use of fertilizers in the farming systems of sub-Saharan Africa from the present average, about 8 kg ha^{-1}, to about 50 kg ha^{-1}. One route to attain this goal is to engender regional joint fertilizer procurement to reduce farm gate price and increase fertilizer demand and use. A review of fertilizer use in Africa has shown that structural changes in fertilizer procurement can reduce farm gate price by 11-18%. Using an average of these figures (15%), this study compares the effect of structural changes in fertilizer market (reducing farm gate price by 15%) on total fertilizer demand, total farm income, and additional farm income with the base situation (using FAO data) under three own fertilizer price elasticity of demand scenarios (low: -0.38; medium: -1.43; and high: -2.24) for 11 sub-Saharan Africa countries. Data were analyzed using Microsoft Excel. Result shows that compared with the base level, structural change in fertilizer procurement arrangement (reducing farm gate price by 15%) led to 6% additional farm income (US$125 million) under low elasticity; 22% (US$472 million) under medium elasticity; and 34% (US$730 million) under high elasticity. Switching from one scenario to another indicates the potential to further increase farm income from 20% to 32%. The paper concludes with the support for structural interventions that reduce farm gate price of fertilizers and other inputs. Such interventions increase farmer productivity, total production, and total farm income and lead to improved livelihoods.

Determinants of fertilizer use in the Chinyanja Triangle of Malawi, Zambia and Mozambique

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Introduction

To sustain food production systems in the SSA and to increase yields, there is the need for substantial increases in use of appropriate inorganic fertilizers as they offer the most effective means of increasing crop productivity (Wilchens, 2006; Weight *et al*, 1998), stimulating economic growth and preventing mining of soil nutrients. The research challenge in the region has been to understand why the use of inorganic fertilizer has not increased. An overarching component of the research agenda has been to assess the socioeconomic factors that affect the use of inorganic fertilizers at the household level. Using econometric analysis, on-going studies in the Chinyanja Triangle of Malawi, Zambia and Mozambique have sought to analyze the socioeconomic processes and factors that influence use of inorganic fertilizers within the maize-based farming systems that are common in the area. The results of the regression model show that despite similar geographical and cultural practices in the Chinyanja Triangle, different socioeconomic variables have different influences on the use of inorganic fertilizers.

The level of education of heads of households is an important determinant of adoption of technologies (Asfaw *et al.* 2004; Jayne *et al.* 2006). The education of the head of household is associated with increased knowledge and therefore more educated people would be expected to be more knowledgeable on the use of fertilizers and on the recommended rates of fertilizer application. Waithaka *et al* (2007) found similar results in Kenya where the amount of fertilizer used increased with the level of education of the head of the household. Kelly *et al.* (2003) also report increased use of fertilizers as a result of promotional strategies such as farmer training, demonstrations, participatory input testing in the Nyanza province of Kenya. In contrast, Ouma *et al*, 2002; Kaliba *et al*, 2000 found in Kenya and Tanzania that the level of education of the household head was not significant in influencing the use of fertilizer. Increased use of inorganic fertilizers and adoption of other technologies generally also appeared to be related to the effectiveness of the extension service (Kaliba *et al.* 2000, Okuro *et al.* 2000).

Results

We found that only in Malawi did households that had participated in agricultural training or exposure to technology, either by study tours to agricultural research centers or through direct training by NGOs, extension department or research use a higher intensity of fertilizer. In contrast, in Zambia and Mozambique training we found that, although training was positively related with fertilizer use, it was not significant. Malawi also had the highest proportion of respondents that had undergone primary and secondary education compared to Zambia and Mozambique. Moreover, Malawi has a more intensive extension system than either Zambia and Mozambique, consistent with the results from the literature reported above.

Fertilizer use intensity was higher when members of households belonged to a group compared to when they did not. Membership in groups implies that farmers without enough resources to

purchase fertilizer can pool such resources together for bulk purchases of fertilizer. Indeed this was reported in discussions with farmers in Malawi and especially those that did not access the subsidized fertilizers. Group extension has also become an important feature of extension services in the region and farmers that belong to groups are more likely to access extension and educational services compared to farmers working individually. Many development organizations and extension departments find it easier, and more cost effective, to work with groups of farmers as opposed to individual farmers. Studies also show a relationship between social capital and adoption and diffusion of technologies and information (Isham 2002, Frank *et al.* 2004, Padmaja *et al*. 2006).

Availability of food and the performance of the previous season have implications on how farmers respond in the succeeding season. The number of months that the main food staple lasted (in this case maize) would elicit different responses in terms of how farmers prepare and act in the next season, depending on availability of resources. Results from Malawi show that households with less food reserves used less fertilizer per hectare than households with more food reserves. This agrees with our hypothesis and could be attributed to the fact that households with less food reserves used up their savings and other available resources to bridge the food deficit at the expense of purchasing inputs. Conversely households that use less fertilizer have lower levels of yields and hence less food reserves. Households with food deficits are also much poorer, have a low resource base and therefore not able to purchase capital-intensive inputs. Households' ability to purchase inputs including fertilizers is determined by their levels of resource endowment, assets, and disposable income (Crawford *et al.* 2003) and the poorer households have less of these resources at their disposal. Reardon *et al.* (1995) view expenditure on production inputs as a function of this capacity to purchase and incentives such as market opportunities as well as policy incentives. The food shortage is more critical in Malawi compared to both Zambia and Mozambique, which explains the why the months of food availability is not a determining factor in the use of fertilizers for these two countries. This may be explained by Malawi facing in the last decade its worst hunger crisis in more than 50 years even though it did not suffer any catastrophic natural disasters like Mozambique nor any major political upheavals (Michael 2002).

Farmers in Malawi and Zambia who grew maize mainly for cash were more likely to use more fertilizer per ha of land than those who grew maize only for food. This agrees with other studies that have shown that much more fertilizer is applied to high value cash crops (Kelly 2005, Henao *et al.* 1999) because farmers usually assess the response to fertilizer applied to a crop in cash terms (Camara *et al.* 2006). In Malawi, farmers using organic manure were also likely to use more fertilizer per hectare of land. In Kenya, Waithaka *et al.* (2007) found a positive relationship between the use of manure and fertilizer in Western Kenya. This is likely because households that use manure are those that own cattle and therefore are wealthier and able to purchase larger quantities of fertilizer.

An unexpected result in the analysis was the negative relationship between farmers who had access to subsidized fertilizer in both 2005 and 2006 and intensity of fertilizer use. We expected that farmers with access to subsidized fertilizer would apply more fertilizer per hectare than those who were not subsidized. In discussions with farmers, it was evident that farmers did not plan to buy fertilizers in anticipation of the subsidy. Indeed, subsidized farmers bought less fertilizer, and only a few farmers bought fertilizer to augment the subsidized fertilizer they received.

Effect of price

In Malawi, farmers pay the equivalent of US$0.44 per kg of fertilizer while the subsidized fertilizer costs only US$0.136 per kg, less than a third the price. When preparing for the 2006/07 season, farmers had only enough cash to buy the subsidized fertilizer and if this was not enough, they were unable to buy additional fertilizer. For this reason they were forced to apply all the fertilizer they had to the whole of their area. We also notes that fertilizer "filtered" into both Zambia and Mozambique. In Mozambique especially, farmers reported their source of fertilizer was subsidized fertilizer from Malawi, where farmers sold their subsidized fertilizers to their neighbours in Mozambique for a high price, and in doing so reduced the amounts of fertilizer that they used on their own farms.

Crawford *et al.* (2003) reported that government programs undercut the private sector fertilizer distributors, which increases their unit costs and leads to low availability of inputs to smallholder farmers. While the fertilizer subsidy program was implemented through a government-affiliated organization in 2005, this was changed to include the private sector in 2006 with the aim of improving the distribution system. This greatly increased the access to subsidized fertilizers by farmers. Of the 357 households surveyed in Malawi, 21.8% received government subsidized fertilizer in 2005/6 growing season, increasing to 46% in 2006/7. However, while the program reached more farmers, it did not lead to increased intensity of fertilizer use.

Cash savings had a positive and significant relationship with the intensity of use of fertilizers in both Zambia and Mozambique but not in Malawi, while total household income was significant only for Zambia. Cash savings enables households to purchase fertilizer and it is also likely that households with cash savings are wealthier enabling them to purchase inputs. Location of the farm plot in the landscape was positive and significant for Zambia in that farmers applied fertilizer more intensively in their main plot located in the valley bottoms compared to uplands. This is in agreement with the finding that when maize is grown more for cash, there is more intensity of fertilizer use. Maize that is mainly grown in the valley bottom in the winter season is sold off as green maize, mainly for cash as opposed to maize grown in the uplands during the main cropping season, which is mainly for household food needs of which any surplus is sold as grain.

Other factors

The area of land cultivated by each household influenced fertilizer use in Mozambique but not in Malawi and Zambia. Farmers cultivating more land were likely to use less amounts of fertilizer than those cultivating less land. This is likely because farmers with larger areas of land can afford to farm less intensively than those with smaller areas. Since the distribution of farm sizes across the three countries were not significantly different, in general Mozambique farmers use fertilizer at a lower intensity than either Malawi or Zambia. Mozambique farmers apply less than 10 kg per hectare of arable land compared to Malawi and Zambia where farmers apply 10-50kg of fertilizer per hectare of arable land (Camara *et al.* 2006). A larger proportion of farmers in Mozambique (62 % and 54% in the 2006/07 and 2005/06 seasons respectively) only applied fertilizer to maize compared with Malawi, where most farmers (53% in both years) also applied fertilizer to other crops. In Zambia, there was little difference in the proportion of farmers applying fertilizer to maize and to other crops for fertilizer. In Mozambique, two important farmer perception variables were significant in determining intensity of fertilizer use. Households that did not perceive themselves as poor were likely to use more fertilizer per unit

area compared to households that perceived themselves as poor. If households perceive themselves as poor, they are more likely to spend resources on basic necessities and immediate needs such as food and not on production inputs that only bring benefits at the end of the growing season. The perception of fertilizers as bad for the soil was also significant and positive. Farmers who perceived fertilizers were bad for the soil used less amounts of fertilizer per unit area. This underlies the importance of farmer perceptions in the promotion of input use.

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Submitted to *Natural Resources Forum*

Output 3. High value commodities

Introduction

The purpose of this output is to produce research results that support the potential for high value crops to reduce inequality between resource-poor and resource-rich farmers while avoiding undermining of the natural resource base. We plan to develop approaches, tools and technologies for improving the competitiveness of smallholder producers of high value commodities, including, but not limited to, a continuation of the research agenda of the former *Tropical Fruits Project* related to System Priority 3A. Our strategy is to contribute to transferable knowledge, tools and methods, for site-specific, pro-poor development, and to promote the lessons more widely in the tropics. The research challenges include those of a traditional nature such as adaptability, adoptability, and selection while maintaining genetic diversity. But new challenges are also involved: in information management and communication; agronomic and financial risk management; business skills development; perishable product nature and traceability; and product functional qualities. Many of the supply chain issues being addressed in Output 2 above are important here, and these two outputs are closely linked.

Five species important to smallholder farmers serve as model crops: naranjilla, Andean blackberry, avocado, soursop and plantain. We are designing and evaluating methods for participatory selection of elite clones before proceeding to methods for their mass propagation, such as rural small- and medium-enterprise nurseries based on tissue culture. Drawing in the expertise of the former project on *Spatial and economic analysis for decision and policy support*, we plan to extend this research to methods and tools for targeting to environmental niches for a wider range of high value crops.

Elite clones of naranjilla and Andean blackberry have been identified from national collections of Colombia and Ecuador. They are currently being tested for resistance to key diseases, and for agronomic performance and farmer acceptance by or in collaboration with national programs. Avocado germplasm for rootstocks is being collected by CORPOICA in Colombia.

Empowering communities through market led development: community agro-enterprise experiences from Uganda and Malawi

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Abstract

The livelihoods of African smallholder farmers are often constrained by poor access to markets and limited entrepreneurial skills for adding value to produce. Rapid urbanization is, however, opening up domestic and regional markets and offering new market opportunities for smallholder farmers to supply higher value produce. Supplying these markets offers both higher income and improved business relations for farmers but accessing these markets also requires important upgrading in terms of product quality, quantities and business management. Research and development organizations have now recognized that improving market access and enhancing the ability of resource-poor farmers to diversify their links with markets are among the most pressing challenges in smallholder agriculture. The present paper highlights the key steps and procedures in building capacity among farmers, farmers' groups, and communities, to identify and evaluate market opportunities, develop profitable agroenterprises, and intensify production, while sustaining the resources upon which livelihoods depend. The paper uses two case studies, in Malawi and Uganda, to describe the approach and synthesizes the main lessons learned. While the approach has been very successful in linking smallholder farmers to domestic markets, the paper argues that these efforts need to be complemented with efforts to develop market institutions that will enable farmers to be competitive and to enter regional and international markets. The paper also analyses the role of strengthening farmer capacity to understand markets, inclusion of gender and equity in these approaches and the role of farmer organizations in ensuring effective smallholder farmer-market linkages.

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Enabling rural innovation in Africa: A framework for implementing integrated agricultural research for development

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Abstract

One of the main challenges of Sub-Saharan African agriculture is the high nature of subsistence of their farming. Many smallholder farmers struggling with small farm sizes as a result of increasing population can only grow enough for food security, with small surpluses for selling. The lack of an entrepreneurial culture, poor access to information and other services and limited access to markets by smallholder farmers also makes it difficult for them to produce for the market. This paper describes the Enabling Rural Innovation (ERI) approach, that CIAT has been implementing in 7 countries in Eastern, Central and Southern Africa. ERI is based on the principles of Integrated Agricultural Research for Development (IAR4D) and builds the capacity of smallholder farmers to generate and access information, develop entrepreneurial skills and demand services from different service providers. ERI is a multi-stakeholder participatory approach to rural innovation, based on collective action, integrative learning and institutional change and aims to empower farmers to understand, generate and use information that helps them respond to their changing circumstances. It places farmers at the centre of research and moves from a supply-driven research agenda to one that is demand driven. The approach is based on: (1). A resource-to-consumption conceptual framework that extends the commodity chain to include NRM, specifically linking to market opportunities, (2). Balancing activities that increase household food security and those that generate income through market-oriented production, (3). A market orientation approach through building capacity to identify and analyse market opportunities for new or existing products, match market opportunities with community assets, develop profitable agro-enterprises and strengthen local networks of business support services, (4). Participatory approaches for research and development, a central feature of the ERI approach. This paper describes the approach and gives some case studies from both East and Southern Africa.

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Enabling rural innovation: Empowering farmers to take advantage of market opportunities and improve livelihoods

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Abstract

This paper presents lessons from applying an innovative action research approach for linking smallholder farmers to markets, over five years in eight countries in eastern and southern Africa. This novel approach, entitled *Enabling Rural Innovation (ERI)*, aims to strengthen social organization and entrepreneurial capacity in rural communities, encouraging farmers to produce what they can market rather than market what they produce. The approach focuses on fostering a development and community-based capacity for the inclusion of rural women and the poor in analyzing and accessing market opportunities (domestic, regional and international). The paper highlights the outcomes of the process using case studies from Malawi and Uganda to assess impacts of applying the approach on rural communities, especially women. Result show that households benefit from linkages to markets in terms of increasing household incomes and changes in intra-household decision-making. Additional income was invested in household items, livestock, savings, sending children to school, improving their houses, and in some instances women purchased land. There were changes in gender decision-making patterns at household level towards more gender equity. The results however show a difference in skills between men and women with women showing lower levels of skills acquisition.

Published

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Summary report of activities in tropical fruits.

Muñoz, L.A.[a], Rodriguez, F.[a], Buitrago, M.E.[a], Mejía, A.[a], Afanador, L.[a], Arenas, A.[a], Lentini, Z.[a], González, A.[a], Lobo, M.[b], Franco, G.[b], Jaramillo, J.[b], Rodríguez, M.[b], Tamayo, P.[b] Ríos, D.[c], Daza, J.[c], Zuleta, J.[d] and Muñoz, J.E.[e]

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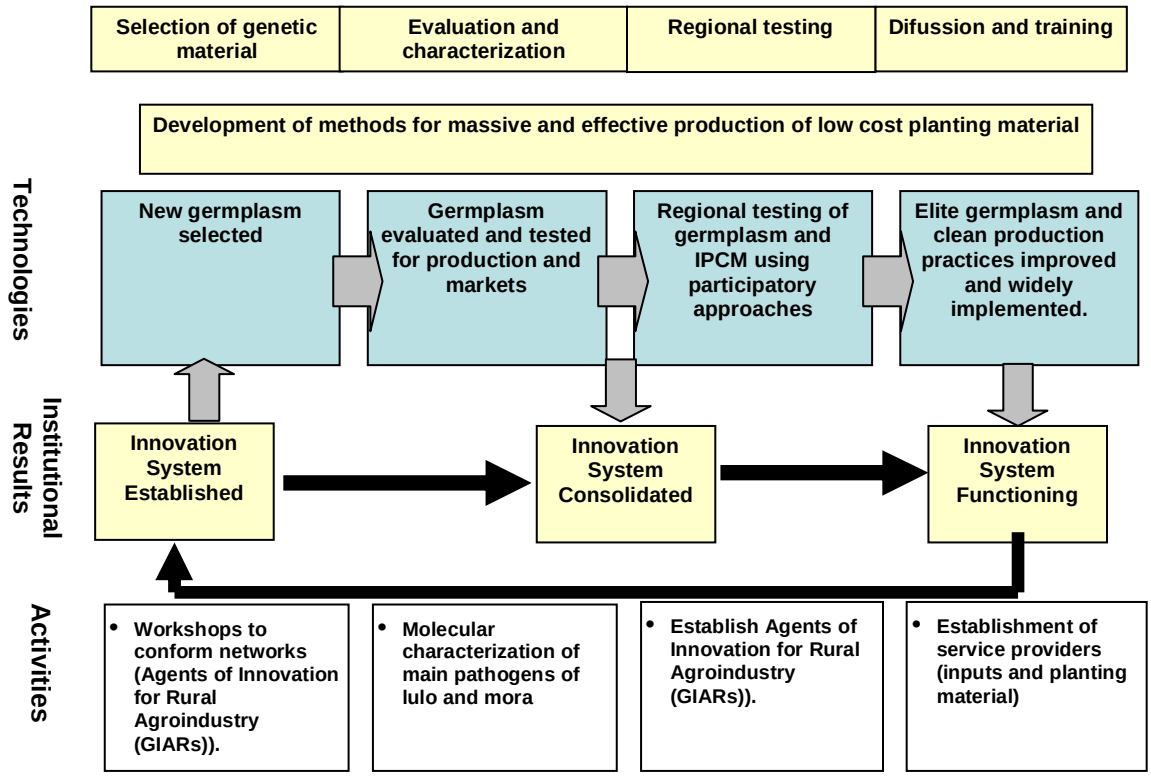
Progress on this output depends on availability of special grants. Research activities are related to ongoing funded projects that fit within CIAT's strategic framework. The research agenda is currently focused on five crops as model crops: naranjilla (*Solanum quitoense*), Andean blackberry (*Rubus glaucus*), avocado (*Persea americana*), soursop (*Anona muricata*) and plantain (*Musa spp*). All these crops are grown by smallholder farmers. Within the high value commodities, the Tropical Fruits group research agenda encompasses a resource to consumption approach, and draws on multidisciplinary skills from within CIAT and from local partner institutions. Activities include participatory selection of elite clones, clean alternatives for pest and disease management, agronomic performance of germplasm, low cost multiplication techniques and the strengthening of innovation process within the supply chain. Figure 1 shows a general framework for implementing projects on tropical fruits in association with partner institutions.

Resource to Consumption Approach



Participatory selection of elite clones of tropical fruits

Muñoz, L.A.[a], Rodriguez, F.[a], Buitrago, M.E.[a], Mejía, A.[a], Afanador, L.[a], Arenas, A.[a], Lentini, Z.[a], González, A.[a], Lobo, M.[b], Franco, G.[b], Jaramillo, J.[b], Rodríguez, M.[b], Tamayo, P.[b] Ríos, D.[c], Daza, J.[c], Zuleta, J.[d] and Muñoz, J.E.[e]

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Introduction

Participatory selection of elite material is being implemented in two crops (*Solanum quitoense* and *Rubus glaucus*) in Colombia and Ecuador. These activities are performed jointly with partner institutions, and germplasm rest mainly on partner organizations, and ocassionally at CIAT.

Activities related to participatory selection of elite clones of these two fruits are being carried out both in Colombia and Ecuador. Research funds are being provided by the Colombian Ministery of Agriculture (MADR) and The Regional Fund for Agricultural Technology (FONTAGRO), through a competitive grant scheme. Funded projects are multi-partner initiatives and include institutions like Universidad de Santa Rosa de Cabal, CORPOICA, Agrosur, Universidad Nacional de Colombia, Universidad de Nariño, Vivero Profrutales in Colombia and INIAP in Equador.

Naranjilla/lulo

Through participatory selection in Colombia, 37 individuals of naranjilla (*Solanum quitoense)* have been identified. Interspecific hibridization (*S. quitoense* x *S. hirtum*), carried out by CORPOICA, produced at least 6 new genotypes, which are also under evaluation. Four plots containing *in vitro* propagated material of *S. quitoense* and interspecific hybrids are being evaluated in four different production regions in the Departments of Antioquia, Risaralda, Cauca and Nariño of Colombia . Clones are being assessed for productivity, fruit characteristics, market acceptance, growth habits and disease resistance. Evaluation of clones is carried out in collaboration with researchers from Universities and NARs located in those areas.

Under semi-controlled conditions, evaluations of the same clones is being conducted for nematode (*Meloydogine incognita*) and anthracnose resistance (see the appropriate article under Output 4). Preliminary data, gathered from a subset of the elite clones evaluated by Corpoica, indicate that nematode resistance might be present in some of the clones (SER 9, SER 15 and SEC 27) currently under field testing (Table 1). Also, two clones of an interspecific hybrid of the polyclonal variety La Selva, show partial resistance to *Colletorichum gloeopsporioides* (See Table 1 in the appropriate article under Output 4).

Table 1. Gall index (Taylor and Sasser 1983) of 10 *Solanum quitoense* and 3 interspecific hybrids (*S. quitoense* x *S. hirtum*) cv La Selva variety. Plants were inoculated with 5000 eggs/plant of *Meloydogine incognita* in pots in the greenhouse. Nematode galls were scored to derive the gall index: 0: 0 nodules; 1: 1-2 nodules; 2: 3-10 nodules; 3: 11-30 nodules; 4: 31-100 nodules; 5:> 100 nodules

Species	Clone	Number of plants	Gall index*
S. quitoense	SER 9	17	2.0
	ER 10	14	4.7
	SER 15	14	2.0
	ER 19	15	5.0
	SEC 27	16	3.0
	EC 28	16	4.7
	SEC 31	17	4.3
	PH SI	17	5.0
	SS E1	13	4.7
	VM E2	17	4.3
	Lulo de Castilla	15	5.0
S. quitoense x *S. hirtum*	HOF+G	14	4.3
	HO	14	4.0
	HFG	15	2.0

* Gall index of 0.0-1.0 = highly resistant; 1.1-3.0 = resistant; 3.1-3.5 = tolerant; 3.6-4.0 = susceptible; 4.1-5.0 = very susceptible.

In Ecuador, INIAP is currently assessing the performance of 12 elite materials selected out of 340 individuals from 36 interspecific crosses. All the evaluated crosses include *S. quitoense* as one of the parents, due to desirable organoleptic properties of the fruits. Other species of *Solanum* spp. have been crossed to *S. quitoense* to incorporate disease resistance, reduce chemical inputs and hopefully replace current commercially grown varieties, which require heavy input of chemicals (2,4 D) to produce fruit of marketable size.

Plots to evaluate the effect of three species of *Solanum* as rootstock on performance of *S. quitoense* were planted in Ecuador and results will be reported in 2008. Rootstocks are evaluated for protection against damage caused by nematodes, *Fussarium* spp. and *Phytophthora* spp.

Andean blackberry/mora

Andean blackberry (*Rubus* spp*)* is grown commercially in the Andes, mainly in Colombia and Equador. High genetic diversity exists in *Rubus*, and it is believed that, even within a single market, fruits come from a complex of cultivated species.

Collections from CORPOICA, and accessiones collected from farmers fields will be evaluated for disease resistance and fruit marketable characteristics by CIAT and associated partners in Colombia. In Equador, through INIAP, we are initiating this process in two provinces where Andean blackberry is commercially grown by smallholder farmers. In 2008, evaluation plots will be established both in Colombia and Equador for testing crop management alternatives, exposing farmers to elite clones and engaging other actors of the value chain in each country.

Collection, characterization, and clonal multiplication of avocado (*Persea americana*) with emphasis on identification of lines tolerant to *Phytophthora* spp.

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Introduction

World production and trade of fresh tropical fruit is expected to expand over the next decade. Developing countries account for about 98 percent of total production, while developed countries account for 80 percent of world imports. The major tropical fruits account for approximately 75 percent of global fresh tropical fruit production. Mango is the dominant tropical fruit produced worldwide, followed by pineapples, pawpaw and avocado (FAO 2003). Latin America and the Caribbean produce 62% of the world's avocados. In 2004, Mexico was the main producer, followed by Indonesia and USA. Recently, plantings in Chile are entering production and this country could then become the world largest producer of avocados. However, avocado is a very important food in many countries, and fruit for local markets is mainly supplied by smallholders. Small growers, and pioneers in planting large areas are faced with a serious threat, the debilitating soil-borne disease, *Phytophthora cinnamomi* (PC), a pseudo-fungus that kills the trees rapidly after they become infected. The use of PC-resistant rootstocks combined with the development of methodologies for their clonal propagation have been the most important strategies to combat this disease in countries like USA (California), South Africa and Australia. Several PC-resistant rootstocks have been identified in these countries. Currently, there are no known rootstocks for the tropics that can tolerate PC and protect both small and large growers from losing their orchards. Moreover, commercial cultivars grafted on to clonal, PC-resistant rootstocks that are sold in international nurseries are too expensive for smallholders. The response of these rootstocks to *Phytophthora* spp. strains found in the tropics has not yet been studied.

To address these problems, a project was funded jointly by the Colombian Ministry of Agriculture and the National Fund for Horticultural products (FNHF, managed by Asohofrucol). The project is to be implemented between 2006 to 2009. Here we describe the main aspects of the project and advances to date.

Main activities

- Collect germplasm with putative tolerance to *Phytophthora* spp. Germplasm will include *P. americana* and other *Persea* spp. that could be used as rootstocks. Collected material will be conserved in the avocado collection held by CORPOICA.
- Establish a broad collection of isolates of *Phytophthora* to be used to test tolerance of avocado germplasm.
- Seek tolerance to *P. cinnamomi* in germplasm collected in Colombia and in imported commercial varieties.
- Optimize methodologies for clonal propagation of avocado rootstocks.

- Train commercial nurseries in clonal propagation of rootstocks.
- Establish demonstration plots using commercial varieties grafted on cloned rootstocks tolerant to *P. cinnamomi*.

Progress to date

Collection of vegetative material. To collect germplasm of avocado potentially resistant to *Phytophthora* root rot, small farms or commercial plantations where disease occurred in the past are being targeted. For this purpose the following geographic regions of Colombia, and Departments within those regions were visited during 2007:

- Southwest: Valle del Cauca, Cauca, Nariño y Putumayo
- Northwest: Risaralda, Caldas, Quindío, Antioquia
- Caribbean Coast: Cordoba, Bolívar, Magdalena
- Northeast: Santander, Cesar, Meta
- Center: Tolima y Huila

A protocol for collection of avocado budwood for grafting has been developed. This protocol includes a treatment of the budwood with a fungicide and an insecticide to prevent pest and disease transport during the collection. When a surviving tree is a non-grafted one, the collection of young branches is enough to reproduce its genetic constitution. However when the surviving tree is a grafted one, the detopping of the tree is necessary in order to induce the regrowth of shoots from the rootstock to initiate its multiplication.

To date 204 accessions, including 11 from detopped trees have been collected from sites sea level to 2240 m of altitude. The age of the collected trees varied between 10 and 100 years, one of them with a trunk circumference of 3.4 m.

In several of the collection sites the pathogens *Phytophthora* spp. and PC have been isolated from the roots of affected trees surrounding the healthy collected trees, indicating that the probability is high that the collected germplasm of these sites is resistant to this pathogen.

Induction of offshoots in rootstocks from adult avocado trees: Many of the commercial plantations that have been affected by PC and in which surviving trees have been found, have been planted with grafted trees. In order to start cloning the rootstocks that may be PC resistant, it is necessary to induce the formation of offshoots. The most efficient methodology to achieve this is through the cutting back of the whole tree below the grafting union (Ben-Yacacov and Zilberstain 1999).

Currently a methodology is being developed that should minimize damage to the trees (avoiding the need for detopping) using growth regulators of the type of the cytokinins applied to the trunk of the tree. The feasibility of such a treatment was first demonstrated by Castro *et al.* (2003), however with a low efficiency (approximately 12% of the treated trees). During 2007 the trunks of 130 trees have been treated with relatively high concentrations of benzyl amino purine (BAP 200 µM and 1 mM) and thidiazuron (TDZ 200 µM, 1 and 3 mM). The response of the trees after 3 months of treatment has been rather low. Only three trees have shown the formation of offshoots. Modifications of this methodology will be tested during 2008 in order to increase this response.

Clonal propagation of rootstocks. The resistance of selected avocado clones to Phytophthora cinnamomi shows a low heritability when the plants are sexually propagated (less than 1%;

Menge 1999). The only way to maintain this resistance is through the vegetative propagation of the plants. Rooting of avocado shoots as a possibility to produce clonal propagated rootstocks, has been achieved in the past, however with difficulty. This strategy has not proved to be a reliable technique for the large-scale production of planting material.

Clonal propagation of avocado rootstocks at commercial level was made possible with the development of the "nurse seed/etiolation methodology" (Frohlich and Platt 1970, Brokaw 1977). This project aims to adapt this methodology to resistant rootstocks isolated in Colombia using low cost materials and substrates.

Initial experiments are being carried out with cultivars used by the nursery Profrutales as source of seeds for rootstock production: Villa Gorgona, Waldin, La Torre and Lula. Also clones identified as resistant to PC have been included (Duke 7 and G755).

The following steps of the "nurse seed/etiolation methodology" are being optimized individually at CIAT, before this methodology is transferred to nurseries: pretreatment of nurse seeds; nurse seed germination; production of nurse seedlings; first graft; etiolation; rooting and acclimatization of etiolated plants in the greenhouse; second graft; and transfer of double-grafted plants to direct sunlight exposure.

After the collected accessions are multiplied and the results of the evaluation of their resistance against *Phytophthora* are available, the methodology will be applied to the identified PC-resistant rootstocks.

Collection of *Phytophthora* strains. The objective of having a broad collection of tropical *Phytophthora* strains is to test, under containment conditions in a greenhouse, the collected and imported avocado accessions for resistance against PC.

Protocols for the safe collecting, shipping and handling of roots of infected avocado trees, and for isolating *Phytophthora* spp. strains out of them, have been developed.

Samples arriving to the pathology lab are processed to isolate the pseudo-fungus and develop single spore colonies. This pathogen is rather difficult to grow in vitro and the use of "living traps" of papaya fruits is required for its isolation. Samples are examined for the presence of pseudo-fungus and treated to induce sporangia from which monosporic cultures are initiated to multiply and conserve the organism. To avoid loosing of pathogenicity during repeated subculturing, small pieces of media are stored in 15% glycerol and double-distilled water at 10° C. Mycelia are collected for DNA analysis.

DNA of the first 18 isolated strains has been sent to the Molecular Diagnostics Lab of USDA for pathogen identification. From these strains, isolated from samples from 6 different Colombian Departments, 10 were classified as PC, 5 as *Phytophthora* spp., 1 as *Pythium* sp. , and 2 as unknown. These results show the efficiency of the implemented isolation protocol. One of the objectives of the project is to isolate 50 strains of *Phytophthora* spp., to study its variability and pathogenicity, and to use the most pathogenic isolates to identify PC resistant avocado germplasm.

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Output 4. Product and environmental quality through IPDM

Introduction

This output corresponds with the agenda of the former *Crop and agroecosystem health management* project. The scope however is reduced by the transfer of work on disease resistance breeding in bean, cassava, rice and forages to CIAT's SBA RDC product lines, as well as by staff cuts.

The focus within this Output is now on the development of technologies for better product and environmental quality through management of diseases and pests. This research is also directly related to SP area 3A. We are developing disease management components and strategies for tropical fruits, in close collaboration with work under Output 3 above on the model crops of naranjilla, Andean blackberry and avocado. Fruit product quality will be vital in the commercialization of these crops, for which inorganic pesticide use is generally unacceptable.

One focus has been on characterization of the genetic diversity of a Colombian population of *R. solanacearum* race 2, causal agent of bacterial wilt of plantain and banana and a very important disease affecting these crops. The DNA pattern suggests that in areas where the two crops are produced together, there is a high risk of non-pathogenic strains of *R. solanacearum* infecting plantain. Consequently, disease management measures need to be developed.

Anthrachnose in Andean blackberry (*Rubus glaucus*, Benth): Genetic variabiliy of the pathogen and source of genetic resistance to the disease in Colombia.

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Objective

Identify sources of resistance to *Colletotrichum* spp. in germplasm of *Rubus* spp., and disease resistance analog genes (RGA) through molecular characterization of the germplasm and existing genetic variability of the pathogen.

Methods

Isolates of *Colletotrichum* spp. have been collected from 38 municipalities, representing a broad region where Andean blackberry is produced commercially in Colombia. Isolates from Departments of Valle del Cauca (53) and Antioquia (30) were evaluated for pathogenicity, using stems cut from a single susceptible Andean blackberry variety under laboratory conditions. Inoculated stems were evaluated every 5 days for 20 days to monitor the evolution of the lesions induced by the pathogen. Area under the disease progress curve (AUDPC) and ANOVA were used to compare different isolates.

To identify species from the *Colletotrichum* genus, we used a combination with primers specific to *C. acutatum* (CaInt2), *C. gloeosporioides* (CgInt), and *Colletotrichum* spp. (Col1) an unidentified species associated to some tropical fruits (Afanador *et al.* 2003). Intraspecific genetic variability of the strains was characterized using random amplification of microsatellites (RAMs), based on the polymerase chain reaction (PCR) (Hantula *et al.* 1996).

Results

A total of 140 samples collected from infected tissue in the Departments of Huila, Quindio and Risaralda gave 100 strains of *Colletotrichum* spp. Preliminary morphological characterization suggested that 63% of the isolates from Quindio and 53% from Risaralda were *C.acutatum*, which affects mainly fruits and peducles. *C. gloeosporioides* is the predominant species in the Department of Antioquia (83%), Cundinamarca (87%), Huila (82%), Santander (67%) y Valle (77%) and is associated to black stem lessions. An independent in-depth study of isolates from the Department of Valle del Cauca, indicated that 81% are *C. gloeosporioides* and 19% are *C. acutatum*.

The area under the disease progress curve (AUDPC) showed significant differences between isolates (Table 1); using 2 LSD values, at least three distinct pathogenic groups were identified. The samples separated into a highly pathogenic group (73% of isolates), medium pathogenic group (10% of isolates) and low pathogenicity group (7% of isolates). The most pathogenic was isolate A034 and the least pathogenic was A040.

Table1. ANOVA for AUDPC of stems of Andean blackberry cv Castilla inoculated with isolates of *Colletotrichum* collected in the Department of Antioquia.

Code	Average AUDPC[1]	Grouping[2]				Code	Average AUDPC	Grouping					
AN034a	46.1			a		AN008b(1)	29.5	f	b	d	e	c	
AN008c	42.0	b		a		AN020a	29.0	f	b	d	e	c	g
AN025a	39.4	b		a	c	AN012	28.1	f		d	e	c	g
AN026a	36.8	b	d	a	c	AN009(3)	27.8	f		d	e	c	g
AN005e	35.4	b	d	a	c	AN013	25.5	f	h	d	e		g
AN006(1)	34.9	b	d	a	c	AN009(1)	23.2	f	h	d	e	i	g
AN036a	34.5	b	d	a	c	AN004f(1	18.2	f	h	j	e	i	g
AN017	34.0	b	d	a	c	AN037a	16.3	f	h	j		i	g
AN033a	32.7	b	d	a	c	AN010(1)	15.5		h	j		i	g
AN007c	32.3	b	d	a	c	AN035a	13.8		h	j		i	
AN004b(1)	32.2	b	d		c	AN014	13.4		h	j		i	
AN016	32.2	b	d		c	AN040	11.2			j		i	
AN011(1)	31.5	b	d	e	c	339 C.gl	6.4			j			
AN015a	30.8	b	d	e	c	45 F.PET	6.4			j			
AN029a	30.6	b	d	e	c	CONTROL	4.7			j			
AN007a	30.3	b	d	e	c								

[1] AUDPC (%/days). [2] P=0.05; LSD=13.84.

Genetic structure of isolates from Department of Valle del Cauca using RAMs allowed discrimination between the two species found there. At a 0.47 level of the Nei-Li similarity, two distinct groups formed: group A for *C. gloeosporioides* and group B for *C. acutatum* (Figure 1). Within the groups A and B, subgroups were associated with geographic origin rather than with pathogenic characteristics. In both species there was high genetic diversity, which is a challenge for disease management, as development of resistance within the pathogen is very likely and will require specific management strategies tailored for each region. There is evidence that there is a distinct response of the two species of *Colletothricum* spp. to benzimidazoles, a group of fungicides commonly used to treat anthracnose. This has implications for disease management in the field.

Conclusions

- Two pathogens, *C. gloeosporioides* (81%) and *C. acutatm* (19%), were associated to anthracnose in Andean blackberry in the Department Valle del Cauca, Colombia.
- There is high level of diversity in isolates of *C. gloeosporioides* and *C. acutatm*, which requires combined approaches between genetic resistance and diverse disease management to improve productivity.
- C. acutatum causes peduncle and fruit necrosis, while *C. gloeosporioides* causes the black lesions of stem necrosis. *C. acutatum* predominates in the Departments of Quindio and Risaralda, while *C. gloeosporioides* is more prevalent in the Departments of Antioquia, Cundinamarca, Huila, Santander y Valle del Cauca.

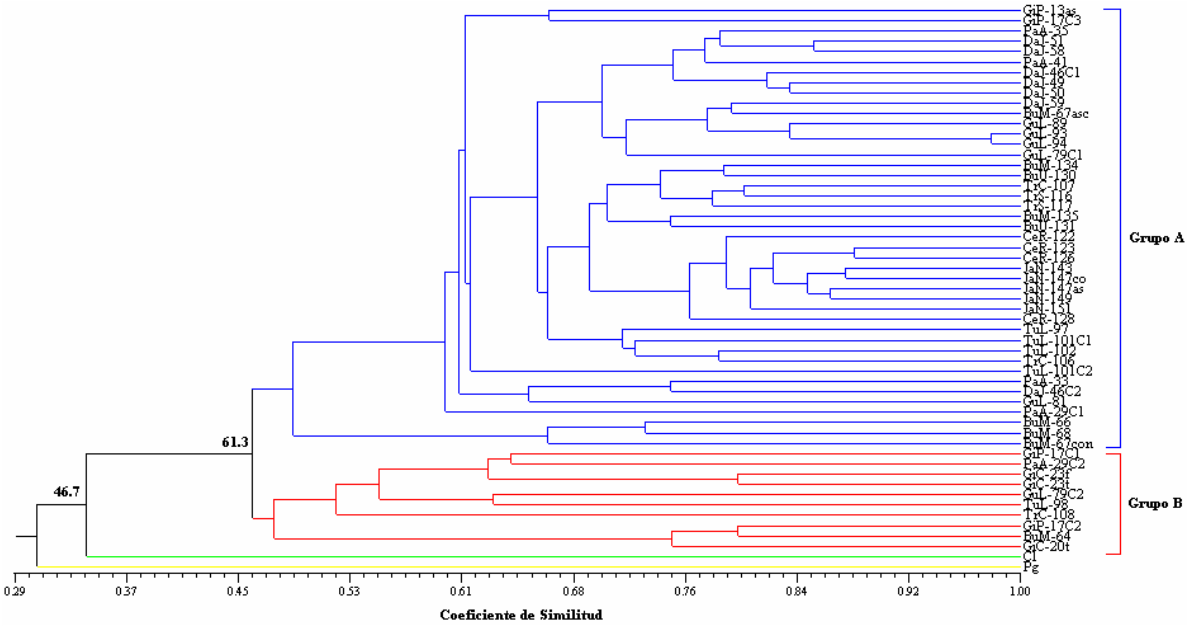

Figure 1. Dendrogram of the genetic structure of 53 isolates of *Colletotrichum* spp. using similarity coefficient index of Nei-Li. Five primers were used to amplify DNA using RAMs. Classification was by the UPGMA method.

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Evaluation of naranjilla/lulo (*Solanum quitoense*) germplasm for resistance to anthracnose (*Colletorichum gloeosporioides*)

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Objective

Identify sources of genetic resistance to *Colletotrichum* spp., causal agent of anthracnose in *Solanum quitoense*, and assess the genetic variability of the pathogen.

Methods

Isolates of *Colletotrichum* spp. were collected from lulo farms distributed across diverse geographic areas in Colombia. Fruits of two interspecific hybrids of cultivar La Selva were used to determine the pathogenicity of isolates. Morphological attributes were used to differentiate different species of the fungus.

Results

Pathogenic characterization of *Colletotrichum* isolates. Initial testing on plants of lulo cv Castilla showed that symptoms developed just three days after inoculation. On the contrary, when isolates were tested on cv La Selva of the interspecific hybrids of (*S. quitoense* x *S. hirtum*), symptoms were not evident until 7 days after inoculation.

Nine days after inoculation the most pathogenic isolates were LM50, LM12 and 43b on clones

Table 1. Percent of fruit surface area affected by isolates of *Colletotrichum* spp.

	Clone La Selva 2		Clone La Selva 3	
Isolate	% area- 7 days	% area- 9 days	% area- 7 days	% area- 9 days
78	0	0	0.09	0.14
76	0	0	0	0
44a	0.44	0.59	0	0
43II	0.13	0.13	0.15	0.51
43b	1.33	1.33	0.52	0.68
42a	0	0	0	0
42a	0	0	0	0
41c	0	0	0.29	0.36
41b	0.63	0.63	0.18	0.27
40a	0	0	0	0
74	0	0	0	0
73	0	0	0	0
71	0	0	0	0
70	0.25	0.25	0	0
69	0.14	0.14	0	0
65	0	0	0	0
59	0.55	0.88	0.11	0.13
50	3.27	3.63	1.01	1.24
48	1.33	3.11	0	0
46	0	0	0.08	0.08
43	0	0	0	0
18	0	0	0	0
12	1.17	1.17	0.93	1.63
6	0	0	0.83	0.81
3	0	0	0	0.59
Control	0	0	0	0
DMS	1.52	2.52	0.79	1.05

Tab1e 2. Morphological characteristics of *Colletothrichum* spp. isolates collected from plants infected with *Solanum quitoense* in Colombia.

Isolate	Colony color										Growth type	Micro-sclerosis	Septum	Sporul-ation
	Gray	Green/ gray	Green-black	Black	White	Beige	Pink	Orange	Gray/ Blue	Yellow				
LM76	0	1	0	0	0	0	1	1	0	0	Radial	Yes	Yes	High
LM03	1	0	0	0	0	1	0	1	0	0	Radial	No	Yes	Low
LM06	1	0	0	0	1	0	1	0	0	0	Radial	Yes	Yes	Very high
LM12	1	1	0	1	0	0	0	0	0	0	Radial	Yes	Yes	Medium
LM18	0	1	0	1	0	1	0	0	0	0	Radial	Yes	No	Low
LM19	0	1	0	0	0	0	0	1	0	0	Concentric	Yes	Yes	High
LM40A	1	0	0	0	0	1	0	1	0	0	Concentric	Yes	Yes	Very high
LM41B	1	1	0	0	0	0	1	1	0	0	Concentric	Yes	Yes	Variable
LM41C	1	1	1	0	1	0	0	0	0	0	Concentric	Yes	Yes	Low
LM42A	1	1	0	0	1	0	1	0	1	0	Concentric	No	No	High
LM42C	1	1	0	0	0	1	1	0	0	0	Radial	Yes	Yes	Very low
LM43A	0	1	0	1	0	0	0	1	0	0	Concentric	Yes	Yes	Media
LM43B	0	0	0	0	1	0	1	1	0	0	Concentric	Yes	No	High
LM43II	1	0	1	0	0	1	1	0	1	0	Concentric	Yes	Yes	High
LM44A	1	0	0	1	1	0	0	1	0	0	Concentric	Yes	No	Very high
LM44B	0	1	0	0	1	1	0	0	0	0	Radial	Yes	Yes	Very low
LM45	1	0	0	0	0	0	0	0	0	1	Radial	No	Yes	High
LM46	0	0	0	0	1	1	0	0	0	0	Radial	No	No	Very low
LM48	1	0	0	0	1	0	1	0	0	0	Concentric	Yes	Yes	High
LM50	0	1	1	0	0	1	0	0	0	0	Concentric	Yes	Yes	Medium
LM59	0	1	0	0	0		1	1	0	0	Radial	Yes	Yes	High
LM65	1	1	0	1	0	0	1	1	0	0	Concentric	Yes	No	High
LM69	0	1	0	0	0	0	0	0	0	0	Radial	Yes	Yes	High
LM70	1	1	0	0	1	0	1	1	0	0	Concentric	Yes	No	High
LM71	1	1	1	1	0	1	0	0	0	0	Concentric	Yes	Yes	Medium
LM73	1	1	0	0	1	1	0	0	0	0	Concentric	Yes	Yes	Low
LM74	0	1	1	0	0	1	0	1	0	0	Concentric	Yes	Yes	High
LM77	1	0	1	1	1	1	1	0	0	0	Radial	Yes	Yes	Very low
LM78	0	1	1	0	0	0	1	1	0	0	Radial	Yes	Yes	High

Nos. 2, 3 and 7 respectively (Table 1).

The most pathogenic isolates grew more slowly compared to the less pathogenic ones, as observed by Alvarez *et al.* (2004).

Morphological characterization: Six significantly different groups (95% confidence limits) were identified. Group A: LM76; group B: LM 42a, LM 44a; group C: LM 45, LM 69; group D: LM 12, LM 18, LM 19 , LM 41b, LM 42c, LM 43II, LM43a, LM 43b, LM 48, LM 50, LM59, LM 65, LM 71, LM 73; group E: LM 03, LM 06, LM 40a, LM 41c, LM 44b, LM 46, LM 70, LM 74, LM 78 and group F: LM 77. Growth characteristics are shown in Table 2.

In 2008, the complete set of elite clones of lulo cv Castilla will be assessed under laboratory conditions.

Conclusion

Two clones of cv La Selva of the interspecific hybrids (*S. quitoense* x *S. hirtum*) showed moderate resistance to *C. gloeosporioides*.

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Elite germplasm and use of biofungicides. Strategies for effective management of antracnose in soursop (*Annona muricata*).

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Objective

Identify sources of genetic resistance to *Colletotrichum* spp. causal agent of antrachnose in *Annona muritica* and assess the genetic variability of the pathogen.

Methodology

Isolates (80) of *Colletotrichum* spp. collected in 11 Departments of Colombia were characterized for pathogenicity in soursop cv Elita. Species of *Colletotrichum* were determined by DNA markers using taxon specific primers CgInt (*C. gloeosporioides*), CaInt2 (*C. acutatum*), Col1 (*Colletotrichum* sp.); morphological genetic diversity of the fungi was evaluated by differences in growth rate in a growth media. Pathogen sensitivity to fungicides was tested against leaf extracts of *Swinglea glutinosa*, *Furcraea macrophylla*, leachate of plantain rachis and against 16 chemical commercial fungicides. Twenty one accession of soursop were characterized for disease resistance against *Colletotrichum* spp. isolates. Pathogen and host genetic diversity were tested using ramdon amplified microsatellites (RAMs).

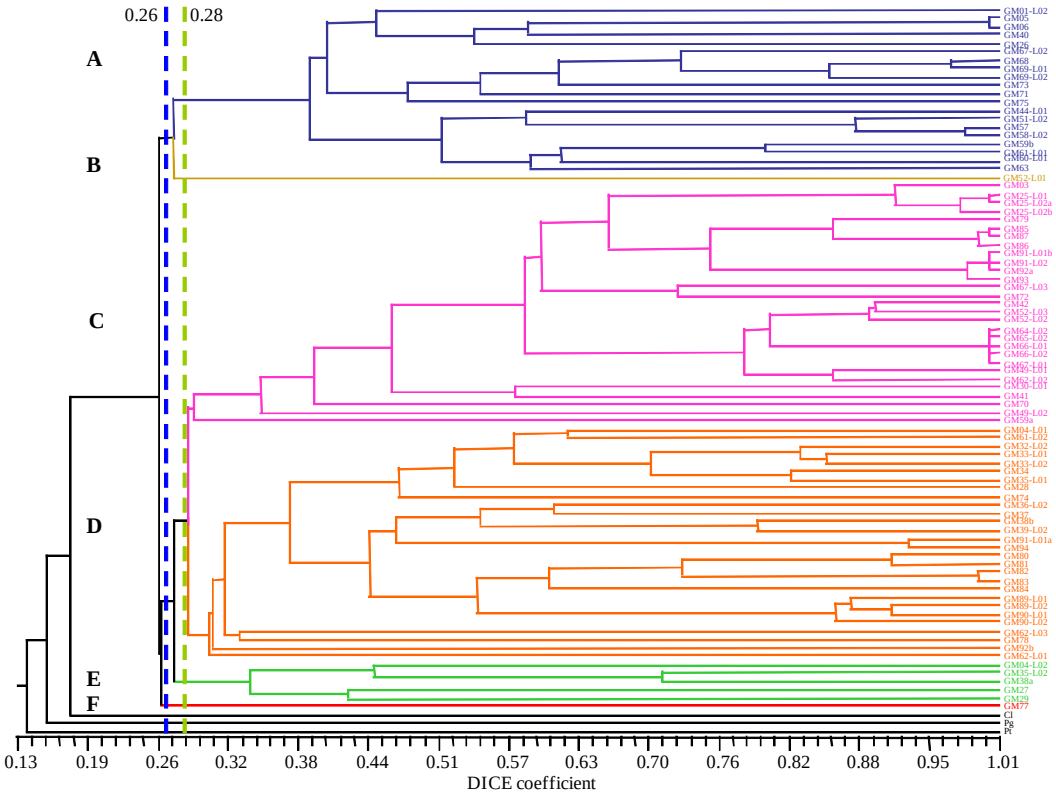

Figure 1. Genetic structure of *Colletotrichum* spp. Isolates found in *Annona muricata* and characterized using RAMs markers. Entries were analyzed using the classification method of UPGMA.

Results

C. gloeosporioides represented 73% of the isolates, 26% were *Colletotrichum* sp., (species not fully identified) and 1% *C. acutatum*. *C. gloeosporioides* isolates were highly pathogenic, while 75% of the isolates of *Colletotrichum* spp. showed very low pathogenicity and *C. acutatum* showed intermediate values. Most of the isolates with very high, high and medium pathogenicity grew very slowly in culture media, whereas those with low pathogenicity grew rapidly. All the isolates that showed very high pathogenicity were grouped together (C, Figure 1), and groups A and B showed very low pathogenicity.

Germplasm was grouped into four groups according to their level of resistance to *Colletotrichum* spp. Group D (J3, Cs2, Cs3 y Cs4) , containing 19.04% of the accesions, were resistant to 83.33% of the isolates. Within this group Joya 3 (J3) showed resistance to 66.6% of the tested isolates. Group A was conformed by most of the susceptible accesions (clone Cítrica4 (C4), Cítrica5(C5), Cítrica8 (C8) y Cítrica9 (C9), Costa Rica (CR), Rojas1 (R1) y Rojas2 (R2)) (C, Figure 2).

Isolates with high and very high pathogenicity showed resistance to most of the active ingredients. One of the leaf extracts (*Furcraea macrophylla*) decreased the growth rate of most of the isolates, indicating its inhibitory power. Leachate of plantain rachis (LRP) increased the growth rate when applied at 50% and 100% concentration (Figure 3).

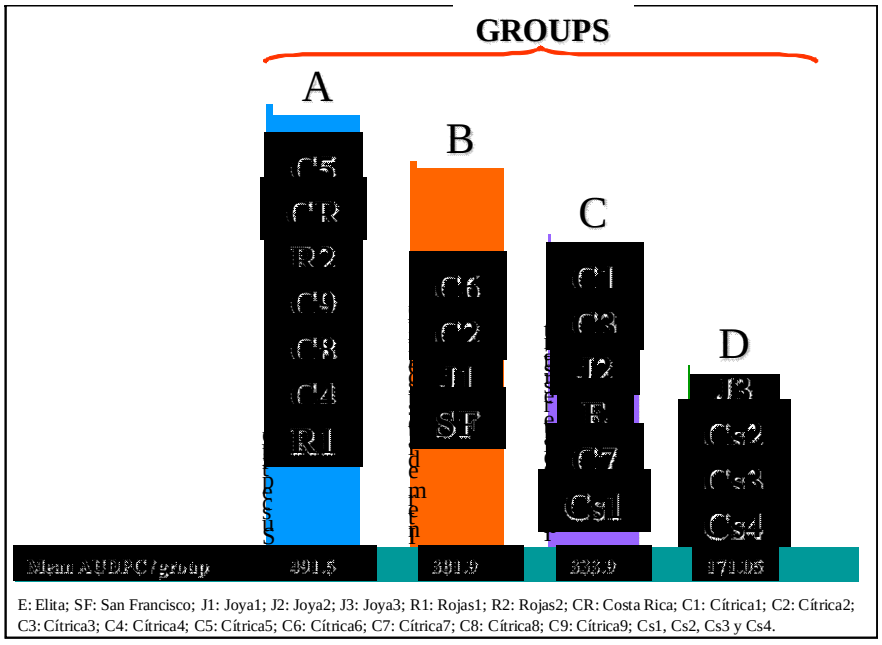

Figure 2. Groups of *Annona muricata* accesions clasified according to their response to *Colletotrichum* spp. Group A was conformed mostly by susceptible accesions while Group D contained accessions that were mostly resistant.

Conclusions

- Soursop germplasm shows differential response to Anthracnose, and some accessions have higher level of resistant to isolates tested.
- Leaf extracts of *Furcraea macrophylla* inhibited growth of *Colletotrichum* spp. isolates.

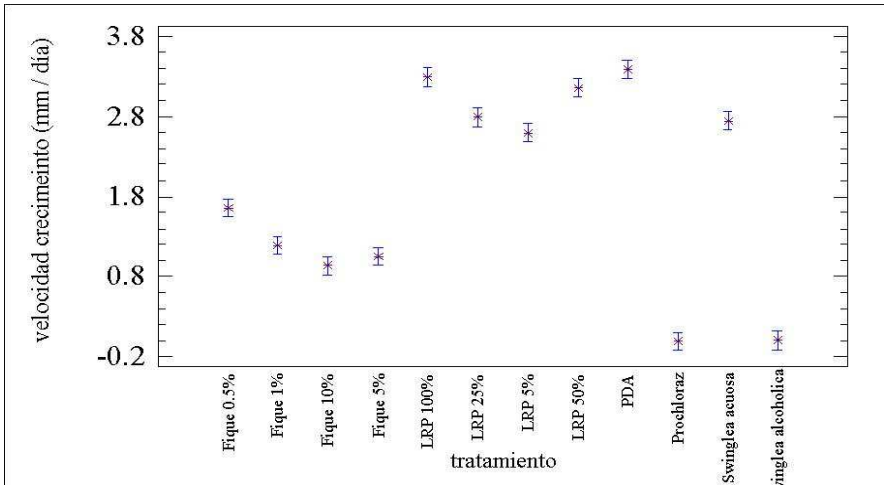

Figure 3. Growth velocity of isolates of *Colletotrichum* spp. treated with different plant extracts and chemical products.

Characterization and identification of phylotypes and sequevars of strains of *Ralstonia solanacearum* from plantain and banana in Colombia.

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Rationale

This study aimed at obtaining information on the genetic diversity of a population of *R. solanacearum* race 2 from Colombia, causal agent of bacterial wilt (moko) of plantain and banana, a very important disease affecting these crops.

R. solanacearum strains race 2 that infects *Musa* spp. are one of the most serious threats to banana and plantain around the world, including Colombia. *R. solanacearum* has been classified into groups according to virulence, through RFLP analysis, studies of sequences of the ITS (16S-23S) regions, and of the endoglucanase (egl) gene. Consequently, they are classified within phylotype II, sequevar 3, 4 and 6. Based on these studies, specific DNA fragments have been used to develop multiplex PCR-based molecular test for *R. solanacearum* race 2 (Allen *et al.* 2005).

Matherials and Methods

Twenty five strains of *R. solanacearum* were classified using characters such as virulence, genetic diversity using RAMs and amplified gene 16S rRNA (Gómez *et al.* 2005). Strains were from plantain (20), banana (1) from the Colomian departaments of Quindío, Antioquia and Meta, and included one control strain from plantain (Colombia), one strain from tobacco (Colombia and USA) and one strain from potato (Australia). Strains were classified using multiplex-PCR, and were divided into phylotypes and sequevars. A phylotype is defined as a monophyletic cluster of strains revealed by phylogenetic analysis of sequence data, in this case the ITS region, hrpB gene and the endoglucanase gene. Amplification conditions followed Fegan and Prior 2005 (cited by Allen *et al.* 2005}.

Results and Discussion.

All strains obtained from Colombia, regardless of geographic origin, tissue, host or virulence belonged to Phylotype II. Control strains from tobacco, plantain and potato were also classified as Phylotype II. (Table 1, Figure 1). Phylotype II is equivalent to division 2, and includes strains belonging to biovars 1, 2 and 2T isolated primarily from America.

Table 1. Origin and pathogenicity of strains of *Ralstonia solanacearum*, 21 strains race 2 causal agent of moko (bacterial wilt), isolated from banana and plantain.

No	Strain	Region	Host	Tissue	AUDPCa	Sequevar	Phylotype			
							I	II	III	IV
1	7	Urabá (Antioquia)	Banana	Fruit	62.17	4		+		
2	39	Quindío	Plantain	Soil	62.00	4		+		
3	57	Fuente de Oro (Meta)	Plantain	Pseudostem	45.63	4		+		
4	588 (58-1)	Fuente de Oro (Meta)	Plantain	Petioles	71.25	4		+		
5	60	Fuente de Oro (Meta)	Plantain	Pseudostem	47.25	4		+		
6	63	Granada (Meta)	Plantain	Pseudostem	50.69	4		+		
7	64	Granada (Meta)	Plantain	Pseudostem	46.13	4		+		
8	66	Granada (Meta)	Plantain	Pseudostem	69.75	4		+		
9	90	Montenegro (Quindío)	Plantain	Petioles	19.25	4		+		
10	91	Montenegro (Quindío)	Plantain	Rachis	19.38	4		+		
11	92	Quimbaya (Quindío)	Plantain	Petioles	63.13	4		+		
12	95	Quimbaya (Quindío)	Plantain	Rhizome	65.63	4		+		
13	96	Quimbaya (Quindío)	Plantain	Pseudostem	33.00	4		+		
14	98	Quimbaya (Quindío)	Plantain	Rachis	59.50	4		+		
15	99	Quimbaya (Quindío)	Plantain	Pseudostem	40.25	4		+		
16	100	Armenia (Quindío)	Plantain	Sucker	71.88	4		+		
17	101	Armenia (Quindío)	Plantain	Pseudostem	58.50	4		+		
18	102	Quimbaya (Quindío)	Plantain	Petioles	1.38	4		+		
19	104	Armenia (Quindío)	Plantain	Fruit	41.25	4		+		
20	106	Armenia (Quindío)	Plantain	Pseudostem	24.75	4		+		
21	109	Armenia (Quindío)	Plantain	Petioles	45.13	4		+		
22	CIAT 1010[1]	Floridablanca Santander	Tobacco			–		+		
23	CIAT 1001[1]	Quency - Florida (USA)	Tobacco	CIAT collection		–		+		
24	G 177[1]	Australia	Potato	CIAT collection		–		+		
25	CIAT 1008[1]	Ibagué (Tolima)	Plantain	CIAT collection	65.13	4		+		

Using the Multiplex PCR technique, all *R. solanacearum* strains isolated from plantain and banana corresponded to Phylotype II, a group shared with strains from other crops like tobacco and potato. Further sequevar analysis inside phylotype II, separated bacterial strains isolated from the genus *Musa* (plantain and banana) from other hosts (tobacco and potato). Strains from *Musa* spp. corresponded to sequevar 4 (351 bp and 167 bp products or only 351 bp product).

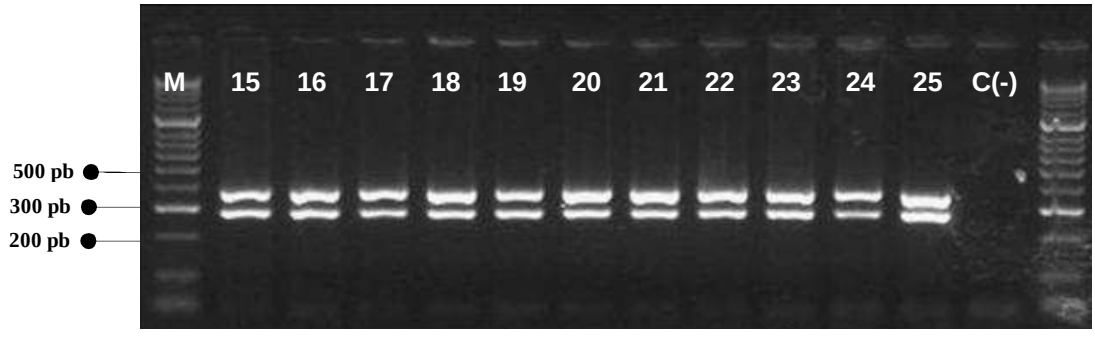

Figure 1. Phylotypes evaluation using Multiplex PCR, of CIAT control strains from banana and plantain. C (-), negative control. M, molecular marker HyperLadder II (100 lanes Bioline®).

Band DNA pattern for strain 1 (351 bp without 167 bp product), isolated from banana growing close to plantain crops in a farm, corresponded to non pathogenic banana (Allen *et al* 2005) (Figure 2, Table 1). This means that the pathogen is able to move between banana and plantain. Although strain 1 was not pathogenic in banana according to its DNA band pattern, it was highly pathogenic on plantain (Table 1).

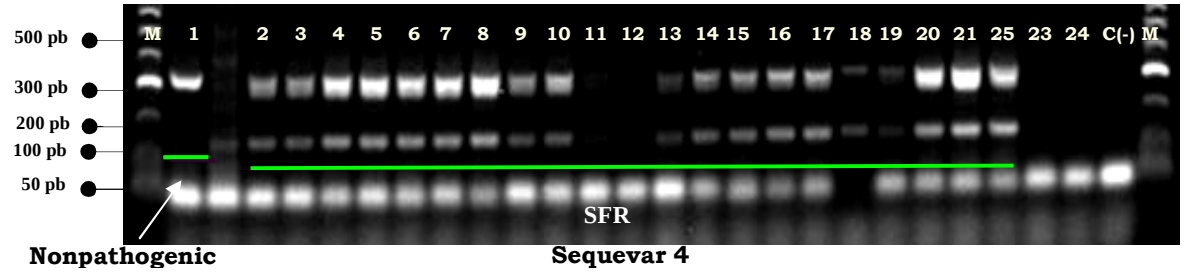

Figure 2. Multiplex PCR Sequevar evaluation of 21 strains from Banana and Plantain. C (- Negative Control. M, molecular marker, HyperLadder II (100 lanes – Bioline®).

Conclusions

- Using Multiplex PCR a strain of *Ralstonia solanacearum* isolated from banana was pathogenic in plantain, and showed genetic identity with a group of strains isolated from plantain around Colombia. The DNA pattern suggests that this strain is not pathogenic in banana.
- In areas where banana and plantain are produced together, the risks of non-pathogenic banana strains of *R. solanacearum* infecting plantain is high. This has important implications for the management Moko disease in plantains, so that risk prevention measures need to be developed in the future.

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Gómez, E. A., Álvarez, E. and Llano, G. (2005). Identificación y caracterización de cepas de *Ralstonia solanacearum* raza 2, agente causante del Moko de plátano en Colombia. *Fitopatología Colombiana* **28:**71-75.

Output 5. Innovations for adaptation to change and vulnerability

Introduction

We aim to make available policy guidelines, tools, and innovations for increasing the adaptation and resilience of agricultural systems to situations of risk, high stress and vulnerability. This new output area responds to SP 4D for intensification in marginal environments. On the one hand, it responds to the global challenge of adaptation to climate change; on the other, it aims to respond to the critical Sub-Saharan Africa regional challenges of soil degradation. It does this through incentives and processes that encourage farmers to invest in soil restoration and interventions at the scales of community, watershed and river basin.

We are supporting adaptation to future climate change by small farmers and their R&D service providers by providing estimates of the agricultural implications of current climatic variability. We modeled climatic suitability for 43 major or high-value niche crops with the aim of understanding the geographic shifts in suitability. While climate change is not all bad news for agriculture, the greatest reduction of suitable areas for current staple crops will occur in sub-Saharan Africa and the Caribbean. We also looked at the threats of climate change on wild crop relatives. Climate change is predicted to affect the range or even the survival of many species, and we highlight the importance of genetic resources and the need for better conservation policies.

In collaboration with PA2 under the TSBF Institute, we are improving the understanding of environmental, social and market dynamics of soil degradation and recovery. We need better tools for identifying effective development policies and associated investments that support the implementation of profitable and resilient land uses and that enhance both welfare and environmental benefits.

In support of the Challenge Program on Food and Water (CPWF), we analyzed the importance of Andean watershed resources in the livelihoods of the poor. We expect improved watershed management to produce only limited direct benefits in terms of poverty alleviation, indirect linkages through labor and service markets may be more important. We have also been reviewing the potential for payments or other forms of compensation for environmental services (such as upstream forest conservation) to protect the soil and water resources. Working with partners across the CPWF basins, we conclude that there is no general relationship between water and poverty: not all water-poor people are poor but not all the poor are water-poor, and people use a near infinite variety of strategies to cope with water stress. Water productivity seems a robust approximate diagnostic, which, with care, can be used to represent the response of agricultural systems to water.

The Amazon challenge

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The Amazon region and its peoples are at a crossroads. The degradation of natural resources, due to poor pasture management, unsustainable slash-and burn agriculture, large-scale commercial agriculture, and logging, has intensified in recent decades. Global climate change is also an issue: the Amazon is both contributor to climate change and will be victim to heating and drying as its effects become more pronounced. In this document, we present a summary proposal for the establishment of a CGIAR System Wide Ecoregional Program in the Amazon. The Program is called the Amazon Initiative Ecoregional Program (AI-EP).

The Amazon Initiative Ecoregional Program

The goal of the Amazon Ecoregional Program (AI-EP) is to contribute to the improvement of rural livelihoods and to the conservation of the Amazon ecosystems through research for development. Interdisciplinary and inter-institutional projects will be designed, implemented and monitored by members of the AI-Consortium, with the leadership of CGIAR Centers and National Agricultural Research Institutions (NARIs). The creation of the AI-EP gives an unequivocal signal of the CGIAR's commitment to a regional research for development support agenda in the Amazon, and will strengthen the institutional, financial and technical base of the current initiative. Figure 1 represents the wider AI Consortium, with the governance and management dimension expressed as the

Figure 1. Representation of structure and mandate of the Amazon Initiative Consortium.

outer layer. The intermediate layer depicts capacity building, knowledge sharing, networking and strengthening governance activities. The AI-EP proposal to the CGIAR is at the heart of the AI Consortium, and focuses on a scientific agenda characterized by the four priority Innovation Foci. The four foci will address the challenges of land degradation, climate change, maintaining

forest ecosystem services and human welfare, and the development of market value chains for Amazon products.

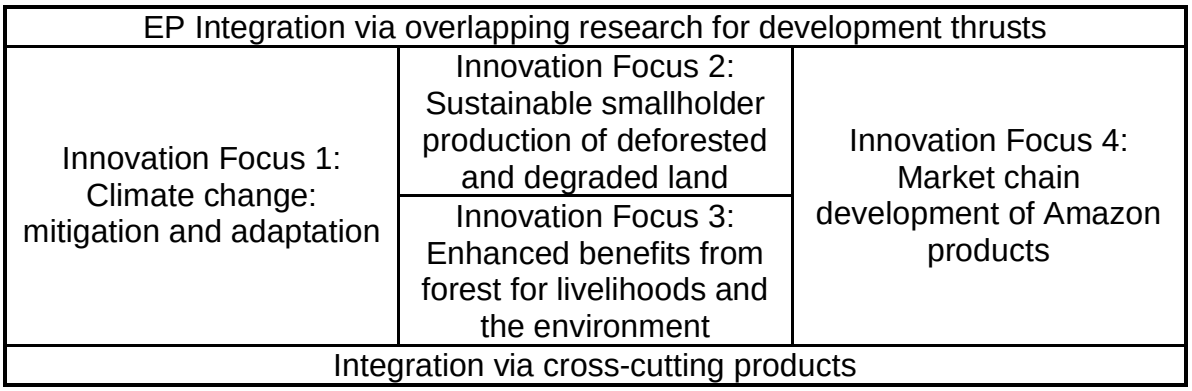

Figure 2. Innovation Foci of the Amazon Ecoregional Program and integration among them

Amazon Initiative Ecoregional Program Innovation Foci

The AI-EP scientific priorities comprise four innovation foci identified by the AI Technical Committee, validated through participatory consultations at sub-regional workshops in the member countries, and refined through an inter-institutional workshop. Figure 2 shows the Innovation Foci of the Amazon Initiative Ecoregional Program, whereas Figure 3 represents the consultation process used to define its scientific agenda.

Amazon Challenges and Development Challenges

The AI-EP faces the challenge of contributing to research and development interventions that concurrently meet the short- and long-term needs of environmental conservation and the economic well-being of local populations. The scientific agenda of the AI-EP has been built around key Amazon and Development Challenges indicated below.

1. Climate Change: Mitigation and Adaptation
   - Mitigation Innovation areas:
     - Analysis of carbon footprint of land use systems
     - Development of resilient land use systems that increase carbon stocks
     - Payment schemes for environmental services, including carbon markets
     - International policy instruments
   - Adaptation Innovation areas:
     - Coping with risk
     - Community based fire management
     - Development of sustainable land use systems adapted to climate change
     - Local and national adaptation policies and programs
2. Combination of Open Access and Insecure Tenure: Adoption of Sustainable Land Use Systems in Deforested and Degraded Areas
   - Innovation areas:

- Technology targeting
- Germplasm or seed supply systems
- Policy research
- Payment for environmental services
- Support systems

3. Sustainable and Value Added Use of the Forest: Enhanced Benefits from Forests for Livelihoods and the Environment
   - Innovation areas:
     - Underutilized forest species
     - Multiple and diversified forest use and management
     - Property rights and resource access
4. The Need for Market Value Chain Development, including Payments for Ecosystem Services: Fair, Financially Attractive, and Effective Market Value Chains
   - Innovation areas:
     - Product identification, ex ante impact analysis, and targeting
     - Product development and seed and germplasm management
     - Production in sustainable land use systems
     - Market value chain development

Integration among innovation foci will be a central feature of the AI-EP. The four foci can be integrated through: strong, natural thematic overlaps, and implementation featuring equally natural joint development of proposals and collaborative project implementation at appropriate common sites (see map).

Opportunities for avoided deforestation in the central Peruvian Amazon

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[c] *International Centre for Research on Agroforestry (ICRAF), Pucalpa, Perú.*

Researchers and policy makers are showing greater interest in the opportunities for avoided deforestation as a strategy to reduce greenhouse gas emissions. If the costs to smallholder farmers of avoiding deforestation are less than other strategies for reducing emissions, tropical countries could potentially enter international carbon markets that would pay them to preserve forests. This project is part of a pan-tropic assessment of the potential of avoided deforestation for reducing greenhouse gas emissions. Researchers from ICRAF, CIFOR, CIAT and national programs used standard methods for assessing the value of different land uses and how these land uses have changed over time at sites in Cameroon, Indonesia and Peru. CIAT and partner researchers assessed the Peru site, a forest margins benchmark site that has been the focus of substantial research in years past.

ASTER satellite images for 1990, 1998 and 2007 were analyzed. Forest was classified into four types on the basis of canopy cover: more than 95% canopy cover, more than 80% canopy cover, more than 65% canopy cover, and more than 50% canopy cover. The other types of land use that were observed were tree crop systems (one type -- oil palm), crop-fallows types (two types – short-duration fallow, shifting cultivation mosaics), and pasture (a combination of native grasses and *Brachiaria* spp.) (Figure 1).

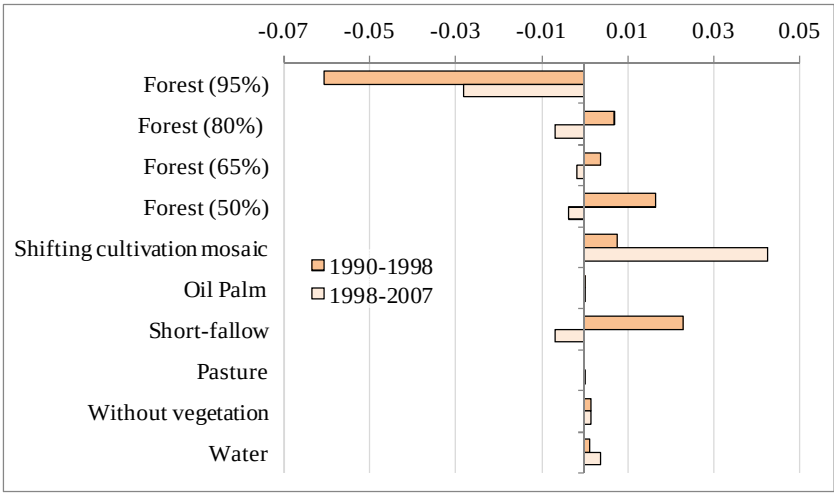

Figure 1. Percentage area coverage for the identified land uses.

The change analysis shows a pattern of deforestation that began the 1990-1998 period and escalated in the 1998-2007 period (Figure 2). Large areas of forest became less dense and the area of shifting cultivation mosaics increased. Somewhat surprisingly, the extent of pasture in the whole landscape was still minimal in 2007.

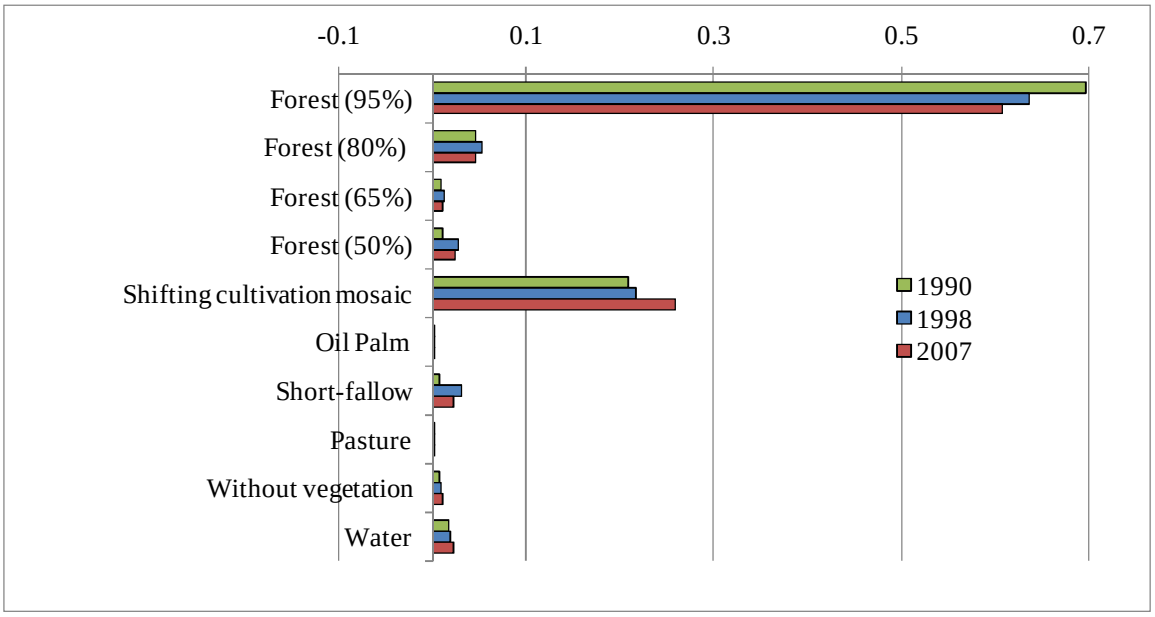

Figure 2. Percentage changes in land use for the 1990-1998 and 1998-2007 time periods, Ucayali, Peru.

The economic value and carbon emissions of the different land uses and land covers over time was used to assess the costs to smallholder farmers of avoiding those uses for the period 1990 to 2007.

Figure 3 presents the abatement cost curve for the Ucayali site in Peru for the period 1998 to 2005. The blue line assumes a 10% private discount rate and the red line assumes a 3% social discount. The results show that the majority of the land use changes generated less than $5 / tonne CO_2-equivalent lost. Results were somewhat higher in the 1990 to 1998 period (graph not shown) than in the 1998 to 2007 period. Low productivity and prices for forest and agricultural goods contribute to a low opportunity cost for carbon. From this information it appears that Ucayali would be suitable for establishing a cost-effective program for *reducing emissions from deforestation and forest degradation* (REDD).

The Peru study together with those in Africa and Southeast Asia suggest that REDD has substantial potential in the global effort to fight climate change by reducing greenhouse gas emissions. However, a series of difficult issues would need to be addressed to make REDD schemes feasible. They must be considered in the context of larger livelihood issues affecting smallholder farmers in the tropics. Schemes will have to integrate assessments at both local and national scales. Issues of assessment, measurement and verification of the amount and nature of deforestation will be critical.

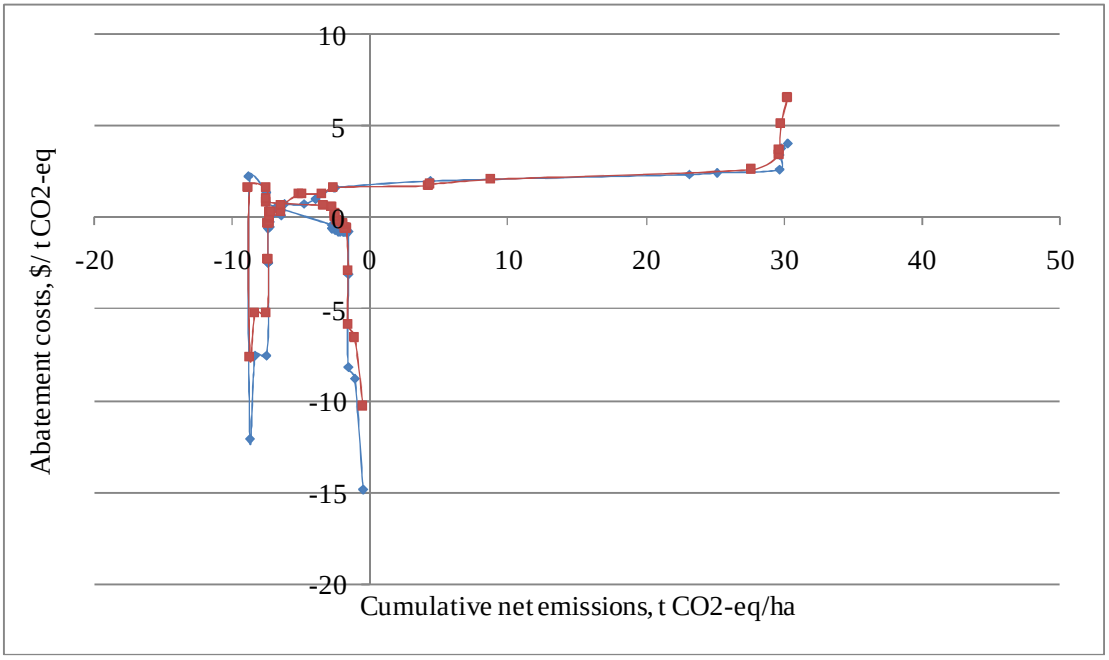

Figure 3. Curve for the Ucayali site in the Peruvian Amazon site showing the level of emissions and their associated abatement costs.

The effect of climate change on crop wild relatives

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Abstract

Crop wild relatives are an important source of genetic diversity for crop improvement. However, the survival of some of these wild plant species could be threatened because of climate change. We used current and projected future climate data for ~2055, and a climate envelope species distribution model to predict the impact of climate change on the wild relatives of peanut (*Arachis*), potato (*Solanum*) and cowpea (*Vigna*). We considered three migrational scenarios for modeling the range shifts (unlimited, limited, and no migration). Climate change strongly affected all taxa, with an estimated 16-22% (depending on migration scenario) of these species predicted to go extinct and most species losing over 50% of their range size. Moreover, for many species, the suitable areas become highly fragmented. Wild peanuts were the most affected group, with 24 to 31 (depending on the migration scenario) of 51 species projected to go extinct and their distribution area on average reduced by 85 to 94%, depending on the migration scenario, over the next 50 years. The number of patches was predicted to decrease by 19% under the no migration scenario or increase by 4% assuming unlimited migration. Patch size decreased by 55 to 60%. For wild potato, 7 (no migration) to 13 (unlimited migration) of 108 species were predicted to go extinct, and their range sizes were reduced by approximately 38 to 69%. The number of patches was predicted to decrease by 34% (no migration) or increase 7% unlimited migration) and patch size decreased by 20 (unlimited migration) to 37% (no migration). In terms of species extinction, *Vigna* was the least affected of the three groups, losing no species (unlimited migration) to 2 species (no migration) of the 48 species in the genus. The mean range size was predicted to decrease by 65% (no migration) or increase 8% (unlimited migration), with 8 - 41 of the 48 species losing more than 50% of their current geographic range. The number of *Vigna* patches increased by 12-115%, but the size of those patches shrunk by 51-59%. Our results suggest that there is an urgent need to identify and effectively conserve crop wild relatives that are at risk from climate change. While increased habitat conservation will be important to conserve most species, those that are predicted to undergo strong range size reductions should be a priority for collection and inclusion in genebanks.

Publication

Agriculture, Environment and Ecosystems (In press) (2008).

Climate proofing agricultural research investments

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Abstract

The case for impending climate change is now proven. Governments can decide, by their action or inaction, to what extent the change will occur; the International Agriculture Research Community will have no say in this whatever. It is up to us to try to maintain our objectives in the face of the possible scenarios. In this paper we discuss the various types of agricultural research projects in terms of their time to fruition and the expected longevity of their products. We look at the information requirements necessary to ensure that these products have the necessary lifetimes to justify the investments in the research.

We show that there are different strategies depending on the type of research that is undertaken.

Basic research into genetic traits and capacities within the available germplasm has to be planned in the long term with outcomes in mind. The vulnerability of the populations and agricultural systems that use developments from this basic research now places priority setting for this type of research in a changing climate and world concept. Ensuring that the germplasm is available for use has taken on a critical new importance with recent studies. Germplasm banks comprise a small fraction of what we will be relying on for the future. Well over 90% of useful genetic variability may still be in the wild. This has to be considered carefully in setting out research objectives.

Plant breeders, who will put together the results of the basic research into useful packages, now have a moving target to aim for. They may not be able to choose their testing sites in present climates to target agricultural populations who will be using their products in the future. Agronomic and agricultural development projects face the most difficult task. How do we develop stable farming systems in an environment that is not only not stable, but that is changing so slowly that the farmers cannot see, or even envisage, the changes.

These are some examples of the problem. The paper sets out to categorize the types of research and information that will be necessary at all levels. We draw on experience from the CGIAR system, and from CIAT in particular. We show that a number of software tools have already been developed that can address some of these problems. We illustrate examples of where this has already been achieved and indicate the way forward to a rather less frantic view of the future.

Publication

Journal of Research on the Semi-Arid Tropics (In press) (2008).

Using agricultural diversity to manage risks of climate change

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Abstract

Climate change will cause shifts in areas suitable for cultivation of a wide range of crops. We used current and projected future climate data for ~2055, and the Ecocrop model to predict the impact of climate change on areas suitable for all crops listed in Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture and other major staple and cash crops. Most detrimentally affected, in terms of reduction of suitable areas for current staple crops will be sub-Saharan Africa and the Caribbean, areas with the least technological capacity to cope. Conversely, regions that will see an increase in suitable area for cultivation are Europe and North America, regions with the greatest capacity to manage climate change impacts.

Breeding for improved resistance to abiotic and biotic stresses is key to minimizing the impacts of climate and other environmental changes. Plant breeders need to increase their attention to breeding varieties that have greater tolerance to local abiotic stresses such as drought, flooding and extreme temperatures and changes in the dynamics of pests and diseases resulting from climatic change. They should take advantage of local ecological knowledge and the rich genetic diversity in landraces and wild relatives of domesticated crop species.

Over centuries of observation and selective breeding, farmers' practices have given rise to traditional varieties that are well adapted to local environmental conditions. Even in the absence of improved varieties tolerant to the direct and indirect impacts of projected climatic conditions, the integration of diversity at both genetic and species levels, increases the resilience and adaptability of agroecosystem to the impacts of climate change. Crop mixtures are more resistant to pests and diseases than monocultures, genetic and population diversity can impart tolerance to biotic and abiotic stresses, and diverse agroecosystems and practices are more cost-effective and reduce negative feedbacks into the Earth system by decreasing the need for costly inputs that undermine environmental services provided by balanced ecological interactions. Thus, the coupling of resistant varieties and diversity-conscious farming provides practical and ready insurance to reduce exposure to the risks associated with climate change.

Publication

Journal of Research on the Semi-Arid Tropics (In press) (2008).

Watershed management and poverty alleviation in the Colombian Andes

Johnson, N.[a], García., J.[a], Rubiano, J.E.[a,b], Quintero, M.[c], Estrada, R.[c], Mwangi, E.[d], Moreno, A.[e], Peralta, A.[e] and Granados S.[e]

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[d] *International Food Policy Research Institute (IFPRI) Washington DC, USA.*
[e] *SCALES Project (CIAT), Cali, Colombia.*

Abstract

Watersheds, especially in the developing world, are increasingly being managed for both environmental conservation and poverty alleviation. How complementary are these objectives? In the context of a watershed, the actual and potential linkages between land and water management and poverty are complex and likely to be very site specific and scale dependent. This study analyzes the importance of watershed resources in the livelihoods of the poor in two Andean watersheds. Results of the participatory poverty analysis reveal large decreases in poverty in both watersheds over the past 25 years, achieved largely by diversification of livelihoods outside of agriculture. Water is an important resource for households' welfare; however opportunities for reducing poverty by increasing the quantity or quality of water available to the poor may be limited. While improved watershed management may have limited direct benefit in terms of poverty alleviation, there are also important indirect linkages between watershed management and poverty, mainly through the labor and service markets. The results also suggest that the interests of rich and poor people are not necessarily in conflict. Sectoral, rather than socio-economic, differences may define stakeholder groups. The findings have implications for policymakers, planners and practitioners in various sectors.

Published

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Agriculture as a provider of ecosystem services: a research and capacity building initiative of the CPWF

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Abstract

Water and People in Catchments (Theme 2) of the Challenge Program on Water and Food (CPWF) and The African Network for Soil Biology and Fertility (AfNet) are involved in a research and capacity building initiative on Payment for Environmental Services (PES) approaches to contribute to equitable and sustainable management of soil and water in upper catchments."

The purpose of the CPWF PES initiative in watersheds is to assess whether the soil and water conservation practices currently being developed to improve farm-level crop and water productivity also have landscape scale benefits, and if so, whether PES mechanisms can act as an additional incentive for their adoption by farmers. The initiative brings together social and biophysical scientists from the CPWF and from the three regional soils consortia, AfNet, Managing Soil Erosion Consortium (MSEC) in SE Asia and Integrated Soil Management (MIS for its acronym in Spanish) in Central America.

The overall objective of the initiative is to integrate AfNet, MIS and MSEC more closely into the CPWF around a participatory, action research agenda focusing on technical and institutional innovation at the landscape scale. The project also seeks to strengthen CPWF research on land and water interactions at multiple scales, e.g. quantify interactions, develop technologies and design governance mechanisms.

In Africa, the objective of the initiative, to be implemented through AfNet, is to incorporate landscape perspectives and social science into soil research, with a payment for environmental services (PES) perspective.

Published

Keynote address to the 24th Annual Conference of the Soil Science Society of East Africa, Embu, Kenya, 26-30 November 2007.

Basin Focal Projects: Report to Feburary, 2008 Meeting of the CPWF Steering Committee

Cook, S.E.

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Overview

The Basin Focal Projects (BFPs) were initiated in 2005 with a set of commissioned projects for the Karkheh, Mekong, São Francisco and Volta basins. After a substantial delay, additional BFPs have just been selected for the remaining 5 basins (Andes, Indus-Ganges, Limpopo, Nile, Yellow) plus Niger. The first set of BFPs are approaching their final stages and are producing valuable insights about the specific nature of the food and water 'crisis' in basins.

Approach

- Analysis in work packages

Each BFP is required to provide analysis in to a standard set of work packages covering: Water poverty; Water availability; Water productivity; Institutional analysis; Intervention analysis and Information and data exchange.

Results are reported in journal, conference and working papers.

- Synthesis

Each BFP produces a synthesis document. Cross-basin synthesis papers are planned.

- Dissemination

Each BFP provides a dissemination plan or impact pathway analysis, which specifies changes, actors and products.

Results

Results are reported briefly against the four questions posed by the CGIAR Science Council which prompted the BFPs.

1. What is the relationship between water, agriculture and poverty?

Methods

- With stakeholders, BFP teams collate and analyze best-available data of poverty at sub-national level and analyze using basic analysis of variance, techniques, regression analysis and Bayesian Networks.
- Reports presented at BFP workshops in Colombo and Cali. Methodological workshops in Accra and Chiang Mai, to expand on basic concepts and explore the utility of Poverty Indices and more advanced methods using diagnostic Bayesian Networks. http://cpwfbfp.pbwiki.com/Water+Poverty.
- Working paper on water poverty: http://www.waterandfood.org/publications/basin-focal-projects.html. 8 papers in draft from the Mekong, Karkheh, Sao Francisco and Volta basins.

Selected lessons /insights.

- No generalizable relationship exists between Water and Poverty. Not all water-poor people are poor, not all poor are water poor. People use a near infinite variety of strategies to cope with water stress. This can be analyzed using the livelihood systems concept.
- Contrasts between situations in the Karkheh, Volta and Sao Francisco basins identify the need to understand water-related poverty dynamics in relationship to the development trajectory.
- Widespread rural poverty in the Volta basin is coupled to persistent low productivity of the agricultural system, in which development is confounded by a suite of factors, including drought risk, poor soil fertility, poor market access, lack of investment and water-related health hazards. Most poverty reduction appears in the south of Ghana, presumably related to the impact of Akosombo Dam.
- Poverty takes a very different appearance in the Sao Francisco and Karkheh basins. In the Sao Francisco, 1m people appear to have been left behind by strong development. Here, commercial agriculture appears to be a strong driver of change. In the Karkheh, food security policy has led to a situation in which rural poverty is less serious than urban poverty (See papers by Torres et al; Giordano et al.).
- Poverty in the Mekong is generally declining but persists in 'hotspots', some of which can be related to water (see paper by Kemp-Bendedict et al.).

2. What is the linkage between global and conditions in basins?

Methods

- Analysis of the condition of water availability and water productivity in basins.
- Reports presented at BFP workshops; 2 working papers produced http://www.waterandfood.org/publications/basin-focal-projects.html; Report on Water Productivity in Lower Mekong (Kirby et al); Approximately 5 papers in draft.

Selected lessons /insights.

- Water productivity seems a robust approximate diagnostic which can be used with care to represent the response of the agricultural system with respect to water.
- In the Mekong, basin-wide estimates of water productivity, as kg/m3 or SGVP/m3 show strong but patchy growth. WPr of Maize has almost doubled in Vietnam and upland areas over the past 10-15 years, but remains largely static in NE Thailand and Cambodia. Increases are most pronounced in the Mekong Delta, which also demonstrates strong growth of aquaculture.
- In the Volta, WPr of Maize is low (<0.2 kgm3) and shows little signs of improvement. Use of crop inputs is low. This may be explained by drought risk, which is moderate in northern Ghana and worsens markedly in Burkina Faso.
- Water productivity in the Sao Francisco shows a contrast between strong and no-growth areas. Areas of low input dryland farming, persists with productivity only slightly higher than in the Volta.
- Growth in the Karkheh appears modified by policies designed to promote food self-sufficiency. Livestock make a significant contribution to a base-level productivity.

3. Significance of River Basin Function

Method

- Water use accounting (Kirby et al, 2008); Ground water assessment (Ahmed et al, 2007)
- Analysis of water availability and sensitivity to change (Water Use Accounts, WEAP modelling, MIKE-Basin); 9 basin Water Use Accounts in Review. 4 papers in draft.
- Specialist workshops on Livestock Water Productivity (Addis, November 2007) and Fish Water Productivity (Cali, February 2008). Draft reports on Livestock water productivity and Fish prodcutivity.

Selected lessons /insights.

- River basins can be organized, from the relatively 'dry' [Karkheh, Limpopo, Sao Francisco] to the relatively 'wet' [Mekong, Ganges]. Agricultural activities follow this pattern. Irrigation or livestock are relatively more important in the former, fish are more important in the latter.
- The contribution of environmental flows, hence the impact of change, is impossible to generalize, however, the basic hydrologic assessments provided by these projects are useful to estimate some impacts of change, for example the risks to Hydro-electric in the Volta imposed by the expansion of small reservoirs upstream, the risks to critical flood flows in the Mekong posed by planned Hydro-electric; or the risks to environmental flows in the Sao Francisco posed by a second 'Petrolina'.
- The prior focus on crop water use appears to have overlooked the importance of livestock and fish. Initial analysis suggests that - in African basins, in particular - most water passes through grassland or mixed crop-livestock systems – in Africa , yet the systemic analysis of these more complex systems has yet to be attempted. The contribution of capture fisheries and (to a lesser extent) aquaculture is very poorly evaluated, yet seems widely underestimated.

4 How do CPWF Projects Contribute to Program Goals?

Method

- Impact pathway method developed (reported separately)
- Extrapolation domain analysis of projects.
- Project activities are contextualised by BFP analysis

Selected lessons /insights.

- The strong growth of aquaculture and crop water productivity seen from the Mekong BFP provides a context to evaluate the widespread significance of innovations developed in crop-fish systems (Project 10) to food and income security in the region.
- Extrapolation domain analysis of aerobic rice (PN 16) identifies the geographical potential of this innovative rice cropping system over very large areas in southern Asia.
- Small reservoirs (PN 46) offer considerable local benefit, but are suspected of posing threats to essential basin flows; in fact, initial analysis in the Volta suggests that they are unlikely to adversely reduce flows.

- The project on the Quesengual slash and mulch system (PN 15) appears to have greater potential outside its region of origin. Project activities help explain chronic loss of soil fertility under similar climatic conditions in the Volta and Mekong basins.

Particular challenges presented by the BFPs:

- Challenge of inter-disciplinary research: The major challenge to the BFPs has been the need for strong inter-discplinary activities, within and between basin teams. Disciplinary boundaries persist:, which hobstructs systemic analysis of complex hydro-agro-scoiological processes.
- Difficulties of securing stakeholder contact: Strong stakeholder engagement can take years to acquire. BFPs did not have this opportunity.
- Data availability: Some basins lack data at a detail necessary for analysis; others possess data which is unavailable in the timeframe required.
- 'Client' identification: Impact pathways identified lattely that the prime stakeholder for BFP outputs is in fact the CPWF itself. The CPWF could assist BFPs by articulating clearling how it will use BFP outputs in Phase 2.

Agricultural water productivity: Issues, concepts and approaches

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Abstract

There are two main concerns in the Challenge Program on Water and Food (CPWF):

1. To improve the livelihoods of the poor whose livelihoods are impaired by lack of access to sufficient clean water; and
2. To improve the overall productivity of water at basin scale ("water productivity").

Access to clean water is considered a basic human right; lack of it is often itself an indicator of poverty. However, in rural areas, the role of water in human well-being is more complex than access to drinking water. Water is used in a variety of productive and consumptive activities. Food production, income generation via agroprocessing or fishing and health can all depend directly on the quantity and quality of available water. Where water is not piped, the time that households must devote to collecting water is a major factor in livelihood options and outcomes.

One of the key features of a livelihoods approach to analysis is that it is dynamic and explicitly recognizes how opportunities and vulnerability affect well-being. Because of their lack of safety nets, the poor are often disproportionately affected by shocks such as droughts, heavy rains or floods. By the same token, mitigation of these shocks can be disproportionately beneficial. The ability of water assets to contribute to rural livelihoods is vulnerable to both natural and social forces, each of which can deal catastrophic blows or contribute to the slow erosion of the quality of, or access to, a resource. In both cases, uncertainty and insecurity affect the contribution of water assets to rural livelihoods, with implications for people's incentives regarding exploitation and/ or conservation. The ability to identify the pressure points, where water assets are critical and vulnerable, is crucial and is not always easy because many of the important driving forces are difficult to observe. Research can play a role in identifying these driving forces and developing ways to assess them empirically, and to mitigate their negative impacts.

The concept of water productivity (WP) is offered by Molden *et al.* (2003)[8] as a robust measure of the ability of agricultural systems to convert water into food. While it has been used principally to evaluate the function of irrigation systems as the amount of 'crop per drop', it seems reasonable to extend the concept to include other types of livelihood support, such as mixed cropping, pasture, fisheries or forests.

Depending on the scale of analysis, the two objectives of improving WP and improving livelihood can appear either congruent or opposite. One of the subtler objectives of the CP is to both improve livelihoods and water productivity through the same interventions.

[8] Molden, D., Murray-Rust, H., Sakthivadivel, R., Makin, I., 2003. A water productivity framework for understanding and action. In: Kijne, J.W., Barker, R., Molden, D. (Eds.) Water Productivity in Agriculture: Limits and Opportunities for Improvement. CABI Publishing, Wallingford, UK, pp. 1–18.

Published

Basin Focal Project Working Paper No. 1. URL: http://www.waterandfood.org/fileadmin/CPWF_Documents/Documents/Basin_Focal_Projects/BFP_restricted/Paper_1_Final_14JY06.pdf

Water productivity: Estimation at plot, farm and basin scale

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Abstract

The concept of water productivity (WP) is a robust measure of the ability of agricultural systems to convert water into food. While it was used primarily to evaluate the function of irrigation systems, as 'crop per drop', it seems useful to extend the concept to include other types of livelihood support, such as mixed cropping, pasture, fisheries or forests. The basic concepts and rationale for estimation are described more fully in the first working paper of this series.

The purpose of this paper is to present ideas of methods of estimating WP at a range of scales, and for different agricultural systems. Water productivity of non-agricultural systems is not considered. A third paper in this series describes how estimates are used to define actionable goals of agricultural water management for poverty alleviation. For now, we assume two basic uses of WP estimates: firstly, WP provides a diagnostic tool to identify low or high water use efficiency in farming systems or sub-systems; and secondly, WP provides robust insight into the opportunities for re-distribution of water within basins towards a goal of increased basin-scale and global water productivity.

In practice, measurement of WP over large areas requires approximations and assumptions that can introduce important errors. The subsidiary purpose of this paper is to enable developers to make judgments about how acceptable these errors are and what alternatives there may be to resolve the technical problems.

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Basin Focal Project Working Paper No. 2. URL:
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Analyzing water poverty: Water, agriculture and poverty in basins

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Abstract

The Challenge Program on Water and Food (CPWF) aims to support the three development goals of poverty alleviation, improved health and environmental security through improved provision and use of water. Poor water availability and use constrains well-being and there are hundreds of case studies illustrating how this occurs. Yet we have not seen a consistent basis on which to evaluate the relationship between water, agriculture and well-being within basins, at scales that can support intervention. In short, we require a coherent analysis of 'water poverty' that provides a reasoned understanding of the degree of water-related constraints to human development. Since we focus on agriculture, this translates into a measure of the shortfall between the potential and actual livelihood support provided by water in agriculture.

The paper discusses the role of water in agricultural productive systems and the way it links to measured poverty. Water poverty is considered as the lack of well-being that can be attributed to water, hence the poverty that could be alleviated through improved agricultural water management. Detailed analysis of water-related poverty proves to be extremely useful to the CPWF and other stakeholders. The role of water in rural livelihoods, and the constraint that it imposes on human well-being due to problems of availability and use are captured in this paper.

Since human well-being is governed by the interaction between resources and the agricultural systems that enable people to derive their livelihoods, the basic concept is that water poverty is a function of the interaction between water and the agricultural system it moves through. In this paper, we review model approaches that identify the conversion of water resource to livelihood outcome in an agricultural system.

This new approach enables a basin-wide analysis of poverty and water, while accommodating more detailed examination of specific livelihood systems. The paper discussed the two-model approach: using dynamic hydrologic modeling to determine the status of water availability and land use / livelihood system modeling to determine the relationship of water with poverty. The paper looks at poverty mapping, the problem associated with the poor with sufficient details at different levels to instigate targeted action. With the poverty maps so developed it will try to understand the logic behind the problem.

Published

Basin Focal Project Working Paper no. 3. URL:
http://www.waterandfood.org/fileadmin/CPWF_Documents/Documents/Basin_Focal_Projects/BFP_restricted/Paper_3_14JY06.pdf

Kampala Focus City Project: Land use change in Kawaala-Kasubi, 2002-2007

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Introduction

There are a number of interlinked issues that have an impact on the sustainability of urban harvest enterprises. Producers engaging in the market and their partners will need to ensure that both the quantity and quality of the products can be met in the short to medium term. Spatial analysis can help in both the planning of enterprises as well as assessing the impact of these enterprises on the natural resource base.

The amount of land available for agriculture in Kampala is limited. There are competing demands for land from industrial, commercial and residential development as well as infrastructure (e.g. Kampala northern by-pass). These other sectors tend to command greater land-rent than does agriculture so there is a tendency for landowners to prefer buildings to fields. The planning system is maladapted (Wekwete 1995) and even where planning rulings zone land for agriculture or other environmental services, the regulations are inadequately enforced (Mahoney *et al.* 2007). Producers are often forced to seek more marginal or 'protected' areas for agriculture; in Kampala these marginal areas tend to be wetlands that have historically been unsuitable for settlement (Lwasa 2005.

Objectives

The objectives of this land use change study are to describe the amount of land dedicated to agriculture and horticulture in the 430 ha study site of the Sustainable Neighbourhoods in Focus (SNF)-Kampala project located in the suburbs of Kawaala and Kasubi. Land use will be assessed at two time periods and projections made to speculate on future land availability and the possible implications for the sustainability of peri-urban agriculture in general and specifically the agro-enterprises selected as part of the SNF-Kampala project.

Methods and Data

Land cover/use change detection and analysis requires land use/cover data from at least two points in time. For this study the best source is the high resolution satellite imagery (image resolution of 0.6 m) of 2002. Since no subsequent images are available, the land cover/use for the second point is from observation in the project site itself. A two-stage primary data collection methodology was devised: the first stage was a reconnaissance using focus group discussions and key informant interviews without the aid of a classified land cover/use map; while the second stage used the digitized land cover/use map of 2002 to guide a purposive sampling frame, data on land cover/use were by visual inspection, recorded with digital photography and augmented by key informant interviews.

The 2002 remotely sensed imagery were digitized using on-screen visual classification and digitization (e.g. Beilfuss *et al.* 2000). The resolution of the imagery and relatively small area allowed for the visual classification of land cover and land use. Multi-spectral imagery were not

available for the area at a resolution suitable to discern differences in land cover required and in fact their use would probably have given inferior results for the project site.[9]

Results

Table 1 shows the conversion of each land use category. This calculation assumes that the changes observed in the sample are repeated across the study area. Agricultural area has declined to 9.8% compared to 25.9% in 2002 while wetland area has reduced from 14% in 2002 to just 1.5% in 2007. The percentage of the study area with bare soil area has increased from 0.9 in 2002 to 5% in 2007. Grassland area has also increased to 7.2% from 3% while urban (Built-up) area has increased from 31% in 2002 to 48%.

Table 1. Land use conversionsin in the Kawaala and Kasubi suburbs of Kampala, 2002-2007.

	Land use 2007 (ha)						
Land use 2002	Agriculture	Bare soil	Mixed use	Grassland	Urban	Wetland	Total (2002)
Agriculture	23.6	11.2	7.9	11.2	58.4	0	112.2
Bare soil	0	3.8	0	0	0	0	3.8
Mixed use	0	0	109.2	0	0	0	109.2
Grassland	0	0	0	8.0	5.4	0	13.4
Urban	0	0	0	0	134.6	0	134.6
Wetland	18.8	6.7	6.7	12.1	9.7	6.7	60.6
Total (2007)	42.4	21.7	123.7	31.4	208.0	6.7	

Conclu

sions

This study was able to identify and describe 6 land use classes that are currently found in Kasubi-Kawala study area. Built-up and agricultural areas are the dominant land use activities in the study site and are triggered by an increase in the population. Due to the greater demand for agricultural products and the conversion of agricultural land for residential purposes, there is a migration of agricultural activities to other land use types e.g. crop cultivation in former wetland areas. Despite the limited land to accommodate agricultural activities in this area, urban agriculture has continued to be practiced in various forms e.g. zero grazing, crop cultivation on small pieces of land, fish farming, chicken and goat rearing in backyards to mention but a few. Not only has urban agriculture remained one of the main income-generating activities for people in this area, it also serves as the main sources of food for home consumption. If the rate of conversion of agricultural land continues at the same rate as between 2002 and 2007 then the backyard agro-enterprises, rather than crop-based enterprises will need to be chosen in order to be sustainable. Further research is required to determine the potential equity impacts on food security and income.

[9] See Antrop and Van Eetvelde (2000), Xia, (1996) and, Martin and Howarth (1988; 1989), for instance, on a discussion of the merits of visual classification of complex landscapes.

The conversion of land from wetland to agriculture and then to urban has been verified by the residents of Kawaala and Kasubi. Monitoring of the changes in land use should be carried out as regular activities of the SNF project so that the rate of change can be monitored and trends determined.

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