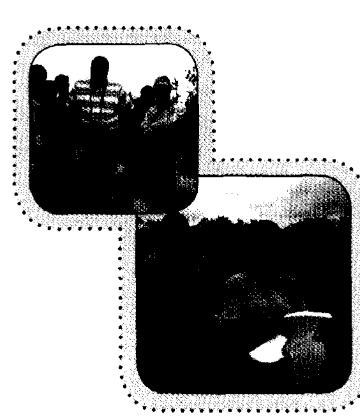
Research on Agricultural Research

Towards a pathway for client-oriented research in West Africa



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Research on Agricultural Research

Towards a pathway for client-oriented research in West Africa

E. Suzanne Nederlof

Proefschrift

Ter verkrijging van de graad van doctor
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PROPOSITIONS

1. Research on agricultural research is a useful tool to reduce the gap between supply-push and demand-driven research (this dissertation).

2. Before engaging in research with farmers, Diagnostic Studies have an essential role to play, not only for identifying and prioritising problems involving all stakeholders, but also for adequately making (pre-analytical) choices that shape the design of agricultural research (this dissertation).

3. The conventional qualifications for promotion and other rewards for researchers do not provide them with incentives to work with and for farmers (adapted from Reij and Waters Bayer, 2001).

4. Instead of strengthening the intervention power of farmer support services, a much faster route to enhancing their effectiveness is to enhance the clout of farmers to make claims on these services (adapted from Röling, 1988).

5. If, as in other countries, it would be customary in the Netherlands for children to remain in school during the whole day (i.e. not be expected to go home for lunch and return from school at three o'clock in the afternoon), more Dutch women would work on their careers without pangs of conscience.

6. The assessment of a dissertation that intends to contribute to poverty reduction or to an improvement of the livelihoods of small-scale farmers should not only apply conventional scientific criteria, but also take into consideration the extent to which it is of use to the intended beneficiaries.

Propositions accompanying the doctoral dissertation Nederlof, E.S. (2006) Research on agricultural research: Towards a pathway for client-oriented research in West-Africa. October 17, 2006.

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During my work on this dissertation much happened in my private life. In September 2002 I married Aubert. He asked work related questions that put me with both feet on the ground and obliged me to go back to the roots. He encouraged me not to shy away from criticism. He helped me realise that some things need to be said, even if they hurt.

In October 2002, we had a son, Tibo, who died only two weeks later. In these weeks I learned more than in the preceding 28 years; he taught me the meaning of life. In February 2005, our son Runi was born. He is a source of inspiration!

In January 2006, I lost my grandmother. We have lived together for many years and I learned much from her analytical skills, broad view and capacity to link events and theories, even though she had never crossed the borders of the Netherlands.

In August 2003, my mother died. I lost much more than just her, I lost a home, a place to be welcomed. This work is dedicated to her.

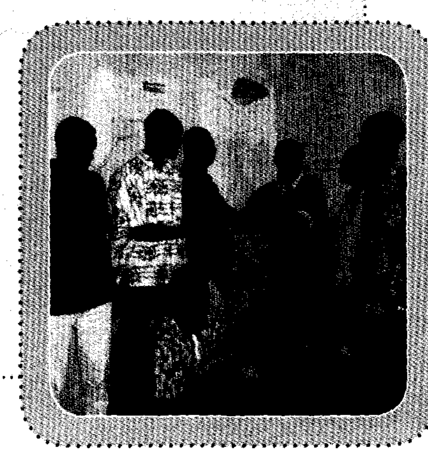
Suzanne Nederlof
Wageningen, 20 mei 2006

ACRONYMS

AgSSIP	Agricultural Sector Services Investment Project
APO	Associate Professional Officer
BSc	Bachelor of Science
CARDER	*Centre d'Action Régionale pour le Développement Rurale*
CdS	Convergence des Sciences
CERES	Research School for resource Studies for development
CGIAR	Consultative Group on International Agricultural Research
CIRAD	*Centre de coopération internationale en recherche agronomique pour le développement*
COCOBOD	Ghana Cocoa Board
CoS	Convergence of Sciences
CRIG	Cocoa Research Institute of Ghana
CSIR	Council for Scientific and Industrial Research
DUEG	Diplôme d'Etude Universitaire Générale
DGIS	*Directoraat Generaal Internationale* Samenwerking
DS	Diagnostic Studies
ERP	Economic Recovery Programme
FAO	Food and Agriculture Organization
FBO	Farmer Based Organisation
FFS	Farmer Field School
FSR	Farming Systems Research
FUPRO	*Fédération des Unions de Producteurs du Bénin*
GNAFF	Ghana National Association for Farmers and Fishermen
GTZ	*Deutsche Gesellschaft für Technische Zusammenarbeit*
HEIA	High External Input Agriculture
IFDC	International Center for Soil Fertility and Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute for Tropical Agriculture
IMF	international Monetary Fund
INREF	Interdisciplinary Research and Education Fund
IPM	Integrated Pest Management
ISNAR	International Service for National Agricultural Research
ISFM	Integrated Soil Fertility Management
LEISA	Low External Input and Sustainable Agriculture
MAKS	Masters in Agricultural Knowledge Systems
MOFA	Ministry of Agriculture
MSc	Master of Science
NAEP	National Agricultural Extension Program
NARS	National Agricultural Research System
NGO	Non Governmental Organization
NWO	Netherlands Organisation for Scientific Research
ORSTOM	*Institut de Recherche pour le Développement*
PCC	Project Coordination Committee
PE&RC	Production Ecology & Resource Conservation
PhD	Doctor of Philosophy
PID	Participatory Innovation Development
PLA	Participatory Learning and Action
PNDC	Provisional National Defence Council
PRA	Participatory Rural Appraisal
PTD	Participatory Technology Development
R&D	Research and Development
RELC	Research Extension Linkages Committee
SIP	*Société Indigène de Prévoyance*
SMPR	*Société Mutuelle de Production Rurale*
TS	Technographic studies
USD	United States Dollar
WUR	Wageningen University and Research Centre

BLOCK 1

GENERAL INTRODUCTION



CHAPTER 1

Multi-stakeholder processes in sustainable land use in West Africa: An introduction to research on agricultural research[1]

Introduction

Agricultural scientists have tried to improve agricultural productivity in West Africa through developing technologies for farmers, and consequently to improve their incomes and welfare and to strengthen the export position and food security of the country in question. Most West African farmers are resource-poor[2]. The question is whether agricultural research has been successful in supporting such farmers' livelihoods in West Africa. Pilot projects have often been able to create conditions that allow spectacular innovation by, for example, providing inputs or credit, but once the artificial conditions are removed the innovation usually can not be maintained (Röling *et al.*, 2004). The CRIG (Cocoa Research Institute of Ghana) courageously admits that only 3.5-7% of the technologies it has developed are adopted by farmers (Ayenor *et al.*, 2004). And CRIG is not an exception. Bie (2001), the erstwhile Director General of the International Service for National Agricultural Research[3] (ISNAR) argues that most of the research results remain beyond the reach of resource-poor farmers. Mutimba (1997) showed for Zimbabwe that resource-poor farmers have consistently and for good reasons refused to adopt technologies that persistently have been promoted by the formal system. Chambers and Jiggins (1987) argue that research has a good record with resource-rich farmers, but a bad one with resource-poor ones. According to Stoop (2002: 13):

1 Some parts of this chapter are adapted from the proposal accepted by the Research School for resource Studies for development (CERES) (Nederlof, 2002) and the proposal granted by Netherlands Organisation for Scientific Research (NWO) (Nederlof, 2003).

2 The use of the term resource-poor farmers and avoidance of small-scale farmers is deliberate. Some small-scale farmers might deploy a capital-intensive agricultural system and are relatively resource- rich as a result. We also did not choose for 'poor' farmers, because West African farmers can be rich in social capital, experience, natural resources etc. In addition, West African farmers tend to resent being called poor.

3 In 2002, ISNAR was disbanded as an independent Consultative Group on International Research (CGIAR) institute and became part of the International Food Policy Research Institute (IFPRI).

"The impact of research on agricultural production in most countries in Sub Saharan Africa, certainly for the marginal semi-arid zones, has remained modest, apart from some widely publicized successes."

And Pretty (1995: 183) writes:

"The history of development interventions is littered with examples of bright new technologies rapidly tarnished by lack of widespread adoption or maintenance."

While many universities have carried out a great deal of research on agricultural extension and education, and have specialised departments to deal with these topics, there are few departments that deal with 'research on agricultural research'. Yet, the relevance of agricultural research for the livelihoods of resource-poor farmers is beyond question and a great deal of theory is either ex- or implicitly applied when designing it. Much money is invested annually in agricultural research in the hope of fostering agricultural development but without empirically-based arguments to support the 'pathways' by which such development is expected to arise. This dissertation is about the impact of research on farmers' livelihoods and represents an exercise in 'research on agricultural research'.

Juma and Yee-Cheong (2005) stress that science and technology development need to be incorporated into the economic strategies of developing countries. Their development priorities include infrastructure, higher education, the promotion of business activity and investment in research. At the request of Kofi Annan, the Inter Academy Council (2004) has written a report to recommend how science and technology strategies can improve agricultural productivity and food security in Africa. It argues that the challenges are to scale-up productivity-enhancing technologies (often available), to develop new options for the future and to suggest the establishment of African centres of excellence for agricultural research. Complementary investments and policies are required, including efficient markets, health and sanitation systems etc., they argue. At the time of writing this chapter (July 2005), investment in Africa was drawing headline attention in the international press, and stimulated discussion on the likelihood that vast sums of additional money would contribute to development in Africa. This dissertation fits seamlessly in this discussion. Investment in agricultural research assumes knowledge and control of the 'pathways' by which research impacts on poverty. It is the contention of the people that contributed to this dissertation and the participants of the Convergence of sciences (CoS) programme as a whole, that these 'pathways' are insufficiently known, or are assumed, based on models that apply in industrial countries (Hounkonnou *et al.*, 2006).

In this dissertation, we[4] argue that the process of formal agricultural research needs to be improved, and that additional criteria for an effective research process need to be developed. The CoS Scientific Coordination Committee (2004: 1) summarizes it as follows:

> *"If, in a certain domain, such as induced agricultural development in West Africa, it seems not to have been possible over time to engage in effective action, the processes of societal knowledge construction (e.g., research) must be re-examined."*

Research can arguably be seen as a process of social construction in that it represents a deliberate effort to make sense of phenomena and events through experimentation, deliberation and other tools for the (co-)construction of knowledge. This perspective raises questions with respect to the nature of the sense-making process, the stakeholders involved in the co-constructions and the implications for resource-poor farmers. Is it possible to design research in such a way that it increases the chances of improving resource-poor farmers' livelihoods? This is the key question that the present study seeks to answer.

Agricultural productivity and profit are not the only criteria by which farmers in West Africa measure the success of innovation. They use a whole range of additional social, economical and cultural criteria as will be extensively discussed in other chapters of this dissertation. This means that agricultural research cannot be seen as goal seeking exercise for goals that can be assumed. Agricultural research can thus be viewed as a 'soft' human activity system. This opens perspectives for study of the operation and impact of agricultural research beyond the purely technical and formal methodology aspects of research and introduces the notion that the impact of research depends on a host of factors that are the domain of social science. In that sense, the present study fits into the family of 'science and technology studies', among which the work of the Actor Network Theorists (Callon and Law, 1989) has become widely known. The dissertation tries to identify an alternative pathway for increasing chances that research has a positive impact on resource-poor farmers' livelihoods. Its objective is to contribute to an agricultural research methodology that is effective and inclusive and enhances the democratisation of science and the accountability of scientists.

During my studies and employees so far, I have encountered several challenges that I could not adequately face at the time. These included dealing with the collaboration between natural and social scientists. In my experience, social scientists were called upon when the natural scientists noticed that farmers 'do not adopt what we told them to adopt'.

4 The use of the term 'we' reflects the fact that a number of chapters have multiple authors.

However, is it not necessary to consider farmers as fully-fledged actors in the research process? Should they not collaborate in all research phases, including the conception and definition of the problem? Yet, it was not clear how natural and social scientists could work together in this endeavour. Research was seen as a link in the chain of research, extension and transfer to farmers, but was there an acceptable alternative? This dissertation addresses these challenges and therefore also is a personal journey towards identifying alternatives for more useful research contributions to the livelihoods of resource-poor farmers in West Africa.

Research for improving farmers' livelihoods

Some definitions

The word science is the old French derivation of the Latin 'scientia' which takes its root from the Latin 'scire', to know[5]. We do not view science as a collection of facts and theories. The process by which we develop theories is science, not the theories themselves. Research concerns the activities conducted during the process.

We distinguish between formal research and informal research. *Formal research* refers to research that takes place in a strictly defined setting, and is guided by professional scientists. *Informal research* is research that occurs as a result of a certain situation, is not planned in advance, and has no formal rules to direct the activities. Informal research is often spontaneous. Mutimba (1997) argues that all research was informal before it was institutionalised. Farmers experimented in their fields, tried out things, learned, improved and adapted. With the institutionalisation of research the understanding of research changed and became what is now referred to as formal research. Formal agricultural research usually is (mainly) aimed at relatively large and resource-rich farmers with high potential for adoption and change. Resource-poor farmers have less easy access to information and findings from formal research. Nowadays, it is realised that (informal) research by farmers is extremely relevant for the heterogeneous conditions of resource-poor farmers as it builds on local practices and knowledge. In this dissertation we explore possible advantages to converge formal and informal science.

Interactive agricultural science (Röling, 1996) brings together the advantages of formal and informal research and is based upon a constructivist perspective[6] on the nature of knowledge that acknowledges that multiple perspectives exist, as well as multiple and often conflicting goals. Problematic issues are approached interactively and in a participa-

5 Concise Oxford Dictionary.

6 Constructivism will be discussed in detail in the next chapter.

tory manner. The role of science is to be an active partner in the social co-construction of reality. What are the consequences of the manner in which co-construction takes place for contributions to improving resource-poor farmers' livelihoods? What pathway help render such social co-construction beneficial to West African resource-poor farmers?

Revisiting studies on 'science and technology'

When the initial successes of the Green revolution in Asia were overshadowed by undesired side effects and the incompatibility of the approach with the African context, questions *on how to design research in such a way that it contributes to improving resource-poor* farmers' livelihoods became increasingly relevant (Lee, 2002). At Wageningen University and Research Centre (WUR) also, the usefulness of research for agricultural development was under debate and interactive agricultural science was explored (Röling, 1996). Van Schoubroeck (1999) deliberately grounded his research in farmers' needs and adapted the research design to allow research to improve farmers' livelihoods. Tekelenburg (2001) proposed a number of research steps to improve the usefulness of research to farmers[7]. Tekelenburg suggested:

1. *Basic and fundamental research to explain and understand the phenomena and identify factors that influence plant and insect growth (basic research, puzzle solving).*
2. *Applied research to improve effectiveness of agricultural management techniques (adapted research, problem solving).*
3. *Hard systems research design to fit technologies to the agro-ecosystems concerned and to optimise production at cropping systems level (hard system design, situation optimizing).*
4. *Improve the situation to the satisfaction of stakeholders as part of decision-making (soft system design, situation improving).*

Before engaging in this research design, the problem situation needs to be analysed resulting in a problem analysis and shared goal setting. Lee (2002) 'tested' these development-oriented research steps in linking the research design to farmer learning. Baars (2002) carried out research on the research structures and methods that best fit the character of organic farming.

What is still lacking is a comprehensive analytical framework for understanding how agricultural research can benefit resource-poor farmers that can inform the design of concrete research projects, the investment in agricultural research and the formulation of training curricula of scientists. In this dissertation we aim to develop such a framework for a pathway of science.

7 The research steps proposed in the Convergence of Sciences (CoS) programme, discussed in the next paragraph, are based on the work of the above authors.

Convergence of Sciences Programme

Interactive agricultural science requires a convergence of sciences. Convergence of sciences refers to, on the one hand, the collaboration between social and natural sciences, and on the other hand between scientists and other stakeholders such as farmers, extension agents, development organisations, policy makers, etc.

The Global Integrated Pest Management (IPM) Facility of the Food and Agriculture Organization (FAO) raised questions about the role of science in IPM Farmer Field Schools (FFS). What can be learned from this process of technology development in a broader context? How can both formal and informal, researcher- and farmer science, be combined for more effective agricultural innovation? How can research be incorporated into experiential adult learning processes? Can research enhance the performance of the FFS[8], and if yes how? How does the FFS approach relate to other approaches for agricultural innovation? These questions resulted in a WUR programme entitled "Convergence of Sciences (CoS): inclusive technology innovation processes for better-integrated crop and soil management" Programme. For an Explanation about CoS, see page 223 of this dissertation. CoS is one of Wageningen's Interdisciplinary Research and Education Fund (INREF) projects. Donors of the programme are the WUR, *Directoraat Generaal Internationale Samenwerking* (DGIS), and the FAO Global IPM Facility. The fieldwork is based in Benin and Ghana and backstopping is provided by Dutch and African scientists. Benin was selected because of successful long-term collaboration with WUR. The INREF programme emphasizes comparative research. Therefore Ghana was proposed as a second country (Meerman *et al.*, 2000: 1). The reasons for selecting Ghana are that it is situated in a different agro-ecological zone[9], and that it has a different institutional context with its Anglophone tradition compared to the Francophone tradition of Benin (van Huis, personal communication January 2005). Partners in Ghana (coordinated by the University of Ghana) and Benin (coordinated by the *Université d'Abomey-Calavi*) carry out the programme. Amongst the partners are governmental services such as the ministries of Agriculture, research institutes and universities, and Non Governmental Organizations.

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8 Some FFS are designed for discovery learning and are not aimed at research; others however, focus on experiments which might generate 'new' knowledge. Bruin and Meerman (2001) explore how FFS could be used as Farmer Research Groups. For further explanations on FFS we refer to our fourth chapter (this dissertation).

9 Agro-ecological zones are land regions sharing similar combinations of soil, landform and climatic characteristics. The particular parameters used in the definition of these zones focus attention on the climatic and soil-related requirements of crops on the management systems under which the crops are grown. (Inter Academy Council, 2004: XVIII)

The long-term objective of the programme is to achieve food security, to improve the livelihood of rural population and to improve natural resource management by developing more effective and efficient systems and approaches for participatory technology development and agricultural extension in integrated crop and soil management (Anonymous, 2001). The short-term objective is to jointly develop a framework for interactive problem identification and development of solutions, with emphasis on the complementary roles of knowledge and problem solving capabilities of the involved stakeholders (ibid). The CoS programme deliberately adds that it aims to contribute to finding more effective ways of developing research processes that will benefit resource-poor farmers. This goal follows from the low impact of previous research on resource-poor farmers' innovative performance.

CoS is based on two main principles, which in turn are based upon lessons drawn from previous research projects. The principles are the following:

1. *Convergence between scientific and local farmers' knowledge. The programme aims to enhance the role of various stakeholders in research and in particular those of farmers: a democratisation of science.*
2. *Convergence between natural and social scientists. The focus of the research will not only be yield increase, but also socio-economical and institutional aspects of innovation. CoS explores possibilities for an effective encounter between the natural and social sciences.*

The CoS programme is an attempt to converge different sciences towards a more interdisciplinary approach, and to enhance technological and institutional elements of innovations, by building on expertise of both African and European scientists. CoS deliberately experiments with new and interactive ways of doing research. CoS therefore provides an exceptional opportunity to learn about a pathway for agricultural research that is beneficial to resource-poor farmers. We present a comparative analysis of experiences within the CoS programme later in this dissertation.

The research on which this dissertation is based was deliberately programmed to be part of a set of nine PhD dissertations of which eight focused on concrete interactive research with farmers on various topics such as soil fertility management, weeds, genetic diversity management, institutional analysis and IPM (see annex I). This dissertation was to take a 'meta' perspective and carry out a comparative analysis of the eight studies with a view to drawing conclusions about 'research on agricultural research'. In that sense, the present study is the outcome of team work and owes a great deal to the efforts of my colleagues in the programme.

Structure of the dissertation

The present chapter sets the scene for the need for research on agricultural research in West Africa. The CoS programme is presented as an opportunity to learn lessons for the design of agricultural research, that is useful for resource-poor farmers. The aim is to develop a comprehensive client-oriented framework for agricultural research and to give insight in:

1. *Improvement of the research design so as to enhance the chances that the research will lead to improved livelihoods of resource-poor farmers in West Africa.*
2. *Improvement of interdisciplinary collaboration among scientists, with a general emphasis on natural/ social scientists.*
3. *Understanding the conditions in and the pathways by which agriculture research can be effective for reaching the Millennium Development Goals .*

In order to realise these aims, the research will address the following research questions:

1. *How does the formal research process work?*
2. *What causes low impact of research on agricultural practice?*
3. *What would be a useful pathway for science impact so as to ensure that the research benefits resource-poor West African farmers?*

As a first step, an initial set of criteria is proposed for the expected outcomes of a pathway for science that is effective in improving resource-poor farmers' livelihoods. This set will be shaped and adapted on the basis of empirical evidence. This is the topic of the first block of the dissertation, which mainly addresses research question one.

As a second step, and on the basis of exploratory trips, two completed research projects in the West African region (not part of the CoS programme) were selected as case studies for refining the initial analytical framework. The adapted analytical framework will give a better understanding of factors that influence the effectiveness of research for resource-poor farmers in West Africa. This second block, addressing principally research question two, will end with an intermezzo in which the framework is revised.

As a third step, discussed in the third block of the dissertation, (some of) the experiences of CoS were analysed using the refined analytical framework. The CoS programme started off with a 'technographic study'. Technography is the basic 'field' within which technological interventions take place. A second phase comprised diagnostic studies, carried out by all PhD researchers in the programme, so as to anchor their research proposals in farmers' needs and specify more precisely the intended beneficiaries and the conditions within which research findings can be relevant (NJAS, 2004). A third phase asked the PhD researchers to work with farmers in field experiments so as to develop technologies that work under farmers' conditions and that are acceptable. A fourth phase asked PhD researchers to develop modules for FFS curricula so as to scale up the impact of their work. The evolving analytical framework developed for this dissertation during the first and second steps, allowed negotiation of collaborative research with the other PhD researchers to analyse their experiences in carrying out field experiments with farmers. In the last chapter we developed a perspective on a pathway of science comprising the research process followed, the criteria to which the research process has to adhere, and the interventions research has to undertake to realize the outcome. Figure 1 provides an overview of the structure of the dissertation.

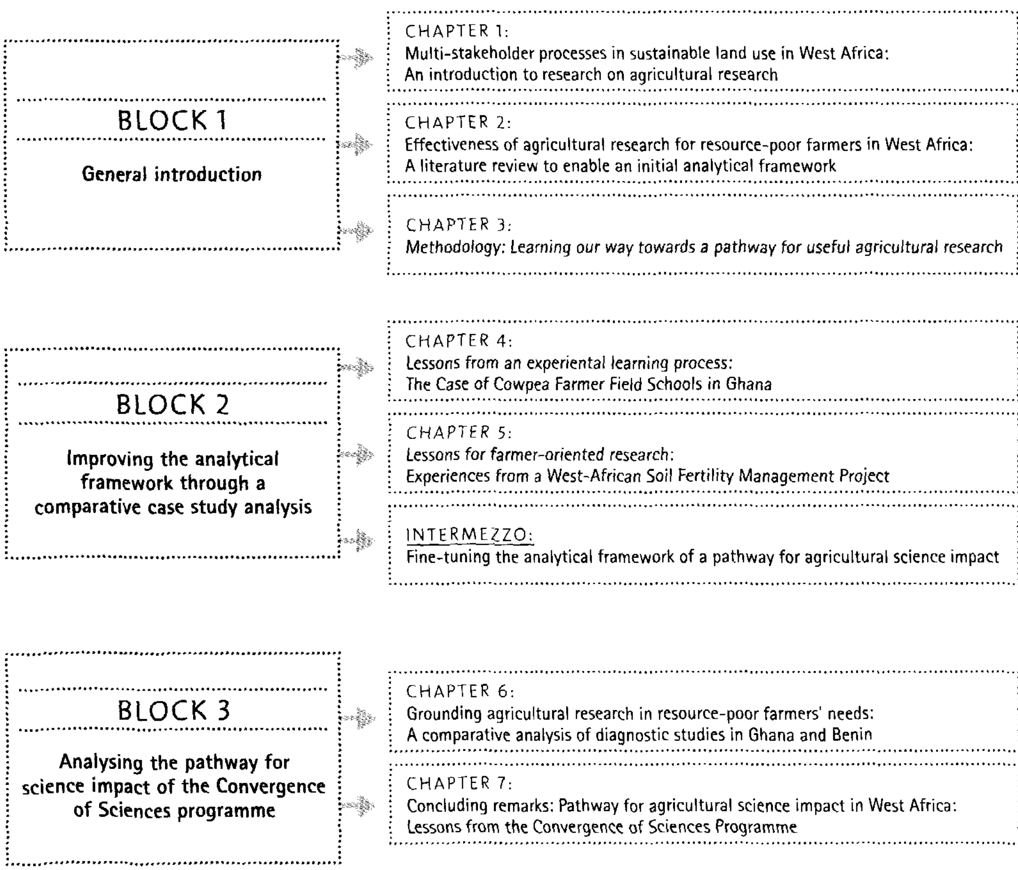

Figure 1: Structure of the dissertation.

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CHAPTER 2

Effectiveness of agricultural research for resource-poor farmers in West Africa: A literature review to enable an initial analytical framework[10]

Introduction

In the previous chapter, we argued that agricultural research in West Africa, on the whole, has not been very successful in improving resource-poor farmers' livelihoods (Bie, 2001; Mutimba, 1997; Chambers and Jiggins, 1987; Stoop, 2002; Pretty, 1995). Two possible main reasons have been put forward for this lack of impact. The first seeks the cause with the farmers. Farmers are backward and do not understand the good technologies that research has developed. For this reason, some science and technology organisations continue to promote technologies that farmers persistently reject, whilst scientists still maintain that farmers will adopt the technology once they begin to understand its advantages better. In this dissertation, we will not explore this explanation. The second possible reason is that there are problems with the research process itself. Chambers and Jiggins (1987) support this position when they argue that the research process discriminates against resource-poor farmers, hence, new methods for taking into account farmers' perspective are urgently needed. Leeuwis (1999a:2) puts it this way:

> *"There is increasing recognition that scientists' design process must be organised in a different manner than before."*

This chapter will explore the second cause for low impact of science in West Africa: it assumes that the process for formal research needs to be improved.

The Convergence of Sciences (CoS) research programme aims to purposely address the second cause and designs and implements innovative research methods aimed at improving research effectiveness for West Africa's resource-poor farmers. The programme is an attempt to try out an innovative pathway of science in order to improve resource-poor farmers' livelihoods and is based upon collaboration between different scientific disciplines.

10 Some parts of this chapter are adapted from the proposal accepted by the Research School for resource Studies for development (CERES) (Nederlof, 2002) and the proposal granted by Netherlands Organisation for Scientific Research (NWO) (Nederlof, 2003).

In this chapter an initial analytical framework, based on existing literature, is proposed as a perspective on research pathways.

After a short discussion of formal agricultural research in West Africa, a description of the theoretical points of departure and main issues, emerging criteria for the expected outcomes of formal agricultural research for resource-poor farmers in Africa are proposed. This analytical framework allows analysing research pathways and is an attempt to construct a frame of researchable variables as an initial perspective to analyse research on agricultural research towards the design of a pathway.

Formal research in West Africa

Pardey *et al.* (1995) explain that formalized agricultural research in Africa began around 1900. Initially, research was conducted in botanical gardens, later the colonial governments set up experimental stations. Following political independence in the 1950s and early 1960s, some countries were cut off from research because the colonial structures collapsed; others found themselves with institutes that addressed export agriculture rather than production constraints faced by resource-poor farmers. Eicher (2003) argues that in the 1950s and 1960s agriculture was not considered an important contributor to economic growth. At the end of the seventies, however, the World Bank provided loans to strengthen agricultural research organizations, and ISNAR was set up to strengthen national research systems in developing countries. Pardey *et al.* (1995: 5) explain that the

> *'africanization of agricultural research occurred more slowly in Francophone Africa than in Anglophone Africa"*

Because whereas the United Kingdom ceded the research institutes in their colonies to the local governments, France managed the research institutes they set up much longer (e.g., Institut de Recherche pour le Développement- ORSTOM or Centre de coopération internationale en recherche agronomique pour le développement- CIRAD). Semi-public agencies and universities did play and still play a minor role in public-sector agricultural research, which is mainly conducted by government agencies.

Different explanations were given to explain why research had such a limited impact on resource-poor framers' livelihoods in West Africa. For an overview see Table 1.

Table 1: Changing explanations for lack of impact of research on farmers' livelihoods

First emerged	Explanation for lack of research impact	Interventions	Methodology/ approach
1950s 1960s	Farmers are backward and ignorant	Agricultural extension teaches farmers the 'right technology'	Transfer of Technology, Training and Visit
1970s 1980s	Farmers do not have the necessary means	Agricultural extension facilitates access to credit, implements and inputs	High Yielding Varieties, Inputs, Package approach
1970s 1980s	The proposed technologies do not fit the conditions of the farmers	Researchers study the conditions of farmers and generate fitting technology	Farming Systems research, On-farm research, Interactive prototyping
Late 1980s	The proposed technologies do not match with resource-poor farmers' goals	Farmers participate in planning and evaluation	Participation (Participatory Learning and Action (PLA), Participatory Rural Appraisal (PRA)
1990s Early 2000	Researchers alone cannot grasp the complexity and the dynamics of local situations	Researchers join forces with farmers (and extension workers) to explore and design viable innovations	Facilitation of learning, Participatory Technology Development (PTD), Farmer Field School (FFS) (in Integrated Pest Management), PID*

Source: Adapted from Scheuermeier *et al.*, 2004: 52

*) PID stands for Participatory Innovation Development. *In PID the systemic knowledge of villagers about their own complex situation is combined with external knowledge, which includes scientific knowledge, as well as the knowledge of farmers from other areas, extension agents, etc. The emphasis is on conducting practical experiments together in villages. The objective is to find new things and ways that work.* (Scheuermeier *et al.*, 2004: 5)

Some of the predominant approaches to agricultural research in West Africa are discussed below.

Transfer of Technology

According to Chambers and Jiggins (1987: 4) in the Transfer of Technology model,

> *"pressure groups and scientists determine research priorities, and then scientists design experiments, conduct these under controlled conditions on experiment stations, in laboratories and in greenhouses, and hand over the results (varieties, treatments, and so on) to commercial interests and extension organisations for adoption and transfer to estates and to farmers."*

Hence, in the Transfer of Technology model, researchers propose innovations and extension is expected to transfer these technologies to farmers through training sessions and visits. This is the so-called linear approach. Farmers' problems are reduced to components and these components are investigated in isolation. Transfer of Technology was implicit in the Training & Visit approach promoted on a large scale by the World Bank. Linear models still are prevalent among many experts and policy makers who decide about investments in research.

Knowledge of farming systems

In some instances in the 1970s, there was a shift away from the predominant top-down reductionist view aimed at technical productivity improvement, towards a more holistic approach (Dixon *et al.*, 2001). Collinson (2000: 1) defines Farming Systems Research (FSR) as

> *"a diagnostic process; a basket of methods for researchers to elicit a better understanding of farm households, family decisions and decision-making processes."*

and continues (Ibid: 4)

> *"Appropriate intervention for farm improvement remains the heart of FSR."*

FSR is applied in technology development, extension and in policy formulation. A farming system is

> *"A population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate* (Dixon *et al.*, 2001: 9)."

The FSR analytical techniques became increasingly participatory and recognised indigenous knowledge. It has gradually been realised that farmers are not empty-headed receivers, but rather knowledgeable and capable actors who have their specific knowledge. It became clear that academic knowledge can benefit farmers, but that indigenous knowledge also can complement the knowledge of academic scientists. Scientists discovered that they have much to learn from farmers and even need their insights to make academic knowledge applicable and relevant. Relations became more equal. This awareness brought about an attitude change, and indigenous knowledge was increasingly valued. Research is seen as having to add to, and build upon, the local knowledge, and to fit into the local practices to be useful for the intended beneficiaries. FSR focuses on problems at the farm level and is client-oriented. Research takes on a more advisory function in FSR. Nevertheless, the responsibilities remain largely in the hands of researchers or other intervening actors, and are not fully transferred to farmers. Chambers and Jiggins (1987: 4) even state that the FSR approach is

> *"tending to turn itself into a variant of the Transfer of Technology model."*

Still, the FSR approach has many advantages over the Transfer of Technology model, because it aims to understand the whole farming system and does not focus on an isolated element. The FSR approach however, did not become mainstream and hence its impact remains limited.

Participation

Both in the Transfer of Technology and the FSR approach, researchers often are in charge of the research process, and farmers themselves are not the deciding force. Participatory approaches emerged in reaction to this. In general, participatory approaches address the failure of implementation of proposed technologies by farmers. The cause for this lack of impact often is that outsiders define the problem and propose the solution, without taking into account farmers' perspectives and conditions. Participatory approaches also include[11] the farmer first and last approach (Chambers, 1990, 1997), farmer-back-to-farmer approaches (Rhoades and Booth, 1982), and farmer participatory research approaches. Chambers (1990) states, that most of what was previously done was based on the participation of only some of the stakeholders. With time, participatory approaches lost their original meaning and participation became a buzzword, sometimes even standing for scientists informing farmers what they should do. Pretty *et al.* (1995: 60) state:

> *"The term 'participation' has different meanings to different people. The term has been used to build local capacity and self-reliance, but also to justify the extension of control of the state. It has been used to devolve power and decision-making away from external agencies, but also to justify external decisions. It has been used for data collection and also for interactive analysis".*

11 For a detailed discussion see Mutimba, 1997.

Even though participatory approaches were conceptually thorough, their practicalities have not always been clearly developed (Farrington, 2000) or implemented. In addition, participatory approaches have been adopted for development activities, but are as yet not an integral part of the research process. Participatory approaches build on FSR in that they involve considering the farming system, and the context in which farming occurs (markets, input delivery systems, institutional framework, community organization etc.).

A well-known tool is PRA (which evolved from Rapid Rural Appraisal). PRA (Chambers, 1994: 1253) has been described as

> *"a growing family of approaches and methods to enable local (rural or urban) people to express, enhance, share and analyze their knowledge of life and conditions, to plan and to act."*

Facilitation of learning

Subsequently, an approach that stimulates structured multi-stakeholder learning emerged, namely, the facilitation approach (e.g., Röling and Wagemakers, 1998a). In this approach emphasis is on multiple stakeholders who have multiple perspectives. Each stakeholder has a contribution to make to a potentially synergetic outcome that is an emergent property of interaction. Focus is on farmers and other stakeholders learning together. So it is not the technology (result) that is the focus but the process and its 'facilitation'. This facilitation approach creates opportunities for innovation and much is yet to be learned about its possibilities and practicalities.

The FFS, developed through FAO's program for IPM in rice in Asia, has been essential in pioneering the feasibility of facilitation of learning as a viable approach (Röling and van de Fliert, 1998, van den Berg *et al.*, 2001; Pontius, 2002). Röling (1995, 2002) analyses the differences between the Transfer of Technology, Advisory and Facilitation models. The CoS programme is based upon the philosophy of the facilitation approach.

Types of research

Within these different research approaches, different methods for research are deployed. Some examples are the following: PTD is

> *"The process of combining the indigenous knowledge and research capacities of the local farming communities, with that of research and development institutions in an interactive way, in order to identify, generate, test and apply new techniques and practices and to strengthen the existing experimental and technology management capacities of the farmers."* (Reijntjes *et al.*, 1992)

The approach aims at helping farmers become more effective technology developers themselves. The PTD approach is a pathway towards Low External Input and Sustainable Agriculture (LEISA). After the green revolution which emerged in risk-prone rain fed conditions, and was based on introducing a High External Input Agriculture (HEIA), it was recognised not only that high external inputs often negatively impact on the environment and health, but also that it is beyond the means of the majority of resource-poor farmers. PTD accompanies the shift towards LEISA options (ibid). Van Schoubroeck (1999) argues that PTD leans on both FSR and Rapid Rural Appraisal techniques.

Another example is *On-Farm Research*. This type of research recognizes that farmers often make rational decisions based upon their (indigenous) knowledge and that this knowledge should be taken into account (Werner, 1996). An important part of the research work is done together with farmers, in their own environment. Some on-farm research is farmer-managed, but the majority of on-farm research remains researcher-managed. The On-Farm research process has three components (Mutsaers *et al.*, 1997): the diagnostic component (understanding the farm and its environment), the experimental component (designing innovations with farmers) and the evaluation component (evaluating performances of the innovation and monitoring adoption). It is stressed that the outcomes of the diagnostic phase are not static but continually changing. However, the decision-making power for options to be prioritised during the diagnostic phase still remains in the hands of outsiders.

Vereijken (1999) developed *interactive prototyping*. This is aimed at the development of sustainable farm production systems and accompanying technologies and practices. It draws heavily on on-farm research. The interactive prototyping of farming systems is an approach with 5 steps: 1) establish a hierarchy of objectives with farmers, 2) transform objectives in a set of multi-objective parameters and quantify them, 3) design a theoretical prototype, 4) lay out the design on pilot-farms and improve until objectives have been achieved, 5) disseminate the prototype to other farms (ibid, Vereijken en Kropff, 1995). Concerns that social scientists raised include that (1) steps two and three remain the task of scientists, and even in the testing farmers do not seem to be recognised as equal partners, (2) the aim is to develop one 'best' farm system and does not recognise the existing heterogeneity, (3) the objectives cannot be revised during the process, and (4) the human component is not considered (Leeuwis, 1999b). Lee (2002) stressed that the prototyping methodology with its emphasis on the social dimension of learning, which she tested in Colombia, had to be complemented with the biological dimension to result in an interactive learning platform and lead to technologies that 'work and are acceptable to farmers'.

Points of departure

Since the early 17th century, science has been dominated by a positivist epistemology[12]. Positivism is based on the assumption that science is able to discover and understand reality and to generate objective knowledge. Naïve realism[13] supposes that the reality exists independently of the human observer. Until recently, agricultural science largely was based on a positivist epistemology and on naïve realism, and assumed that only one reality exists and that science is able to discover and explain it. This approach still prevails in a number of research institutes. An alternative perspective to the positivist epistemology is constructivism. Constructivism departs from the idea that (human) beings actively and socially construct their reality (Maturana and Varela, 1998). Radical constructivists assume that human beings construct everything and hence nothing exists. We reject this point of view. Individuals and collectives can die or collapse if they construct realities that are not effective in maintaining structural coupling with the environment (Röling, 2000). Structural coupling refers to the idea that human beings construct reality in such a way that they are able to maintain an effective interface with their environment. As a result of this point of departure there are multiple realities and every human experientially and socially constructs his or her reality in close interaction with the surrounding environment.

Since the early 17th century, problems were more often than not analysed with the view to identify one single solution or propose a component technology. Often such efforts take place within an arbitrarily limited area of discourse or discipline. This approach is called reductionism. It reduces a problem to the smallest unit of analysis, habitually within one scientific discipline. Reductionism often goes along with positivism: one can only discover the reality by reducing it to tangible pieces. The contrast to reductionism is holism. Holism means that a problem is studied in its context, emphasising relationships among elements in the whole (or system) and often from the perspective of several scientific disciplines.

A paradigm is a way of looking at the world. Kuhn (1962) defines a paradigm as the point of departure for science, the frame in which scientists work and of which they do not question the borders anymore (Koningsveld, 1995). A paradigm is made up of epistemology,

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12 Epistemology is the theory of the method or the grounds of knowledge (the Concise Oxford Dictionary). Assumptions about the method or grounds of knowledge determine to a large extent the relation between the researcher and his or her study object.

13 The counterpart of naïve realism is relativism.

ontology[14] and methodology (Guba and Lincoln, 1994). Research in a positivist-reductionist (techno-centric) paradigm assumes that 'the truth' can be objectively known and that science can formulate generalisable truths (Röling and Wagemakers, 1998b). In such a paradigm, the focus is on developing technologies to solve elements of a problem from a single disciplinary perspective (component technologies) without deliberately taking into account the wider context. Such an approach is perhaps essential as part of a strategy for developing technologies that work. In this paradigm it is not necessary to include farmers and their views. However, so far empirical data (see previous chapter) show that the technologies developed within a techno-centric paradigm often have not been implemented on a large scale. Hence, a positivist- reductionist approach is perhaps a necessary, but not sufficient, condition for improving resource-poor farmers' livelihoods. Additional paradigms are emerging in the field of sustainable agriculture (see 'quadrants' in Figure 1).

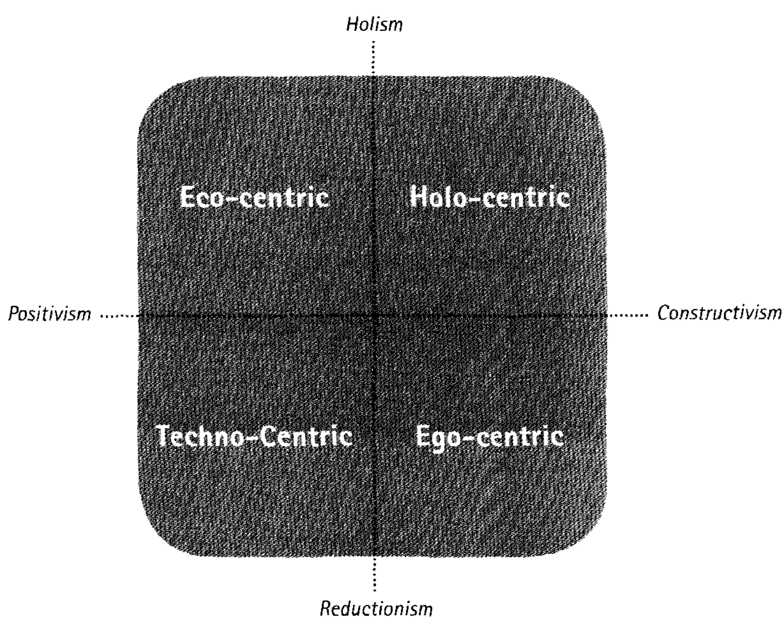

Figure 1: Scientific paradigms for sustainable agriculture,
Source: Adapted from Miller, 1983 and 1985 and Bawden 1997 by Röling, 2000

14 Ontology is the science or study of being; the part of metaphysics which relates to the nature or essence of being or existence (Concise Oxford Dictionary).

The role of science in alternative paradigms that move towards a more holistic and/or constructivist epistemology is not only to invent useful realities, resulting in the generation of appropriate technologies, but also to understand the multiple realities of the stakeholders involved and to find solutions based on shared learning. In such paradigms, therefore, farmers and their views must be involved. The complexity of our society requires such a shift towards a more holo-centric paradigm. According to Röling (2000), a holo-centric paradigm recognises that multiple stakeholders are involved and that negotiated agreement is the basis for dealing with complex problem situations. Röling (ibid, Funtowicz and Ravetz, 1993) argued that the current 'age of the environment', and the inherent uncertainties that cannot be solved by puzzle-solving science require a paradigm shift that involves a change in epistemology (from positivism to constructivism), in ontology (from reductionism to holism) and in methodology (from extractive truth seeking to participatory learning and development).

All quadrants are needed for a more successful co-construction of knowledge to improve farmers' livelihoods. The CoS programme (ibid) argues that all quadrants represent a useful perspective, and that scientists need to be able to move between them and operate in the discourses of each of them. On the basis of the above we adopt Scientific Coordination Committee's (2004: 5) definition of research:

> *"Research is a deliberate effort to (co) construct coherent and correspondent cognitive agency among a set of specified stakeholders, so as to improve the effectiveness of their actions in their domain of existence."*

If multiple cognitive agents move to engagement in concerted action we call this social learning. The CoS programme intends to facilitate such social learning.

After eight years of critical design and analysis of the research approaches used in a successful development project in Bolivia, Tekelenburg (2001) has proposed a typology of research activities that are essential for resource-poor farmer development. He suggests (Tekelenburg (2001; also Röling *et al.*, 2004: 225-226) the following fundamental questions that must *all* be answered to achieve 'development' outcomes:

1. *What are the useful a-biotic and biotic relationships that can be construed?* This requires fundamental science.
2. *What can technically make a difference?* This concerns applied research. It aims to reveal the best available technical means for assured human problems. It is the most common form of agricultural research.

3. *What can work in the context?* This requires an analysis of the context in which resource-poor farmers live, their agro-ecological zone, market analysis, input provision, infrastructure, etc.
4. *What can work in the farming system?* This is the main question the Farming Systems Research Approach (see above) addressed. It concerns insight in the local system including labour availability, gender relations, knowledge, access to land, market opportunities, etc.
5. *What will be acceptable?* Research outcomes might work in the context and the farming system but it does not mean that farmers will accept it. Whether a system is appropriate and acceptable to farmers depends on such factors as farmers' enthusiasms, alternatives, cultural inclinations, experience, and livelihood strategies as well as better-quality insight into local conditions and constraints. This requires that scientists do not consider their knowledge as superior, but involve farmers and their indigenous knowledge in the research process (participatory approaches discussed above).
6. *How can the outcomes be scaled out and up?* Scaling out concerns expanding the impact of the research beyond the farmers involved and beyond the time duration of the project. Scaling up involves creating the framework conditions (in terms of policies and institutional support) for the sustained use of the new practices developed.

Tekelenburg's (2001) work has greatly influenced our approach to 'research on research'. The basic point raised by Tekelenburg is that, in order for agricultural research to be effective from a development perspective (and enhance social learning amongst multiple stakeholders); it has to include *all* the components in this typology in a specific mix. Most research is limited to only one or two of the approaches in the typology. The point of departure of the CoS programme is that a pathway for agricultural research that is effective for resource-poor farmers comprises the complete mix.

The first two questions posed by Tekelenburg are answered in a techno-centric approach, question three and four in an eco-centric approach and questions five and six in a holo-centric approach. Within the CoS programme an attempt was made to address question 3 to 5 during the diagnostic studies and question 1 and 2 during the developing technologies with farmers phase while taking into account question 3 to 6. Question 6 is the main question to be answered during the second phase of the CoS programme, yet to be designed. Figure 2 is an attempt to incorporate Tekelenburg's typology in the quadrants of Figure 1.

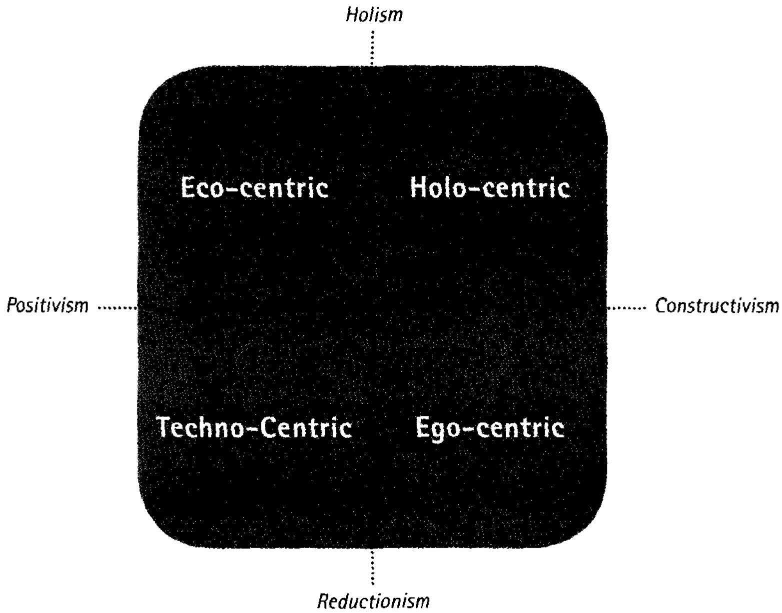

Figure 2: Approaches to research in quadrants,
Source: Adapted from (Miller, 1983 and 1985, Bawden 1997 in) Röling, 2000; Tekelenburg, 2001

In a techno-centric paradigm, the main criterion for successful research is the extent to which technology generated solves a component problem, usually defined by the researcher. In an eco-centric approach systems that take into account all ecological factors and combines technical disciplines. For example varietal resistance, biological control, cultural control practices and judicious use of pesticides in IPM. Research from a holo-centric point of view has to meet additional criteria. If such additional criteria are met, chances are better that formal research will generate technologies that improve farmers' livelihoods and enhance sustainable innovations. In this chapter, we propose criteria for the expected outcomes of research as initial elements for an interactive framework as a perspective on a pathway of science.

Issues in agricultural research

From the overview of agricultural research approaches and methods several lessons can be drawn about what is important if research is to be useful for resource-poor farmers in West Africa. Issues impacting on the success or failure of agricultural research are:

1. *Learning process with stakeholders (participation, platform-building). Learning is the key to interactive research.*
2. *Social/ biological science mix. It refers to the interdisciplinary encounter of social and biological insights required for issues of societal importance (Röling, 2000).*
3. *Democratisation of science. This refers to the increased influence of the intended beneficiaries and stakeholders on the design, implementation and impact of the research. Hence, agricultural research becomes more client-oriented through the participation of farmers, scientists and other stakeholders.*
4. *Context. Farmers do not operate in isolation but conditions such as their surroundings, the world market and global trends allow them (or not) to benefit from science.*

These issues are further explored hereunder.

Ad 1. Learning process

Learning is the development of

> *"perceptions to fit opportunities or threats [...] and adapt action and purposeful behaviour to changed perception". (Röling, 2000: 14)*

Kolb (1984) describes the learning process as a cycle composed of the following elements: (1) concrete experience, (2) observation and reflection, (3) generalisation and conceptualisation and (4) experimentation. A learning process implies a combination of convergence, coherence, increased social capital and increased correspondence (Gibbon *et al.*, 2003). Maarleveld and Dangbégnon (1999) identified four questions that form the basis of the analysis of learning processes. The questions are: Who learns? What is learned? Why is it learned? How is it learned? Important for a learning process are the participation of stakeholders and the formation of a platform to engage in a collaborative learning process. Participation is a tool to facilitate learning. A platform is a group of stakeholders with a common interest who join forces to reach a common goal (Dangbégnon, 1998, Dangbégnon *et al.*, 2001).

Different people understand different things when talking about participation. Pretty (1994, 1995, *et al.*, 1995) developed a ladder of different types of participation, see Box 1.

Box 1: Pretty's ladder of participation

Source: Pretty, 1994, 1995, Pretty et al, 1995

The different types of participation are the following:

1. *Passive participation (people participate by being told what is going to happen or has already happened, the information being shared only belongs to external professionals).*
2. *Participation in information giving (people participate by answering questions, people do not have the opportunity to influence proceedings, as the findings are neither shared not checked for accuracy).*
3. *Participation by consultation (people participate by being consulted and external agents listen to views, these external agents define both problems and solutions, there is no share in decision-making and professionals are under no obligation to take on board people's view).*
4. *Participation for material incentives (people participate by providing resources [for example labour or fields] in return for food, cash or other material incentives, farmers are not involved in learning).*
5. *Functional participation (people participate by forming groups to meet predetermined objectives related to the project, such involvement tends to be after major decisions have been made, institutions formed intend to be dependent on external initiators and facilitators but might become independent).*
6. *Interactive participation (people participate in a joint analysis that might lead to action planning and the formation or strengthening of local institutions, it tends to involve interdisciplinary methodologies that seek multiple perspectives and make use of systematic and structured learning processes).*
7. *Self-mobilization (people participate by taking initiatives independent of external institutions to change systems, they contact external institutions for resources and technical advice and retain control over how resources are used).*

The type of participation carried out in a research project tells us something about the involvement of resource-poor farmers and as such the nature of the learning process. The way in which farmers and researchers participate in and have control over the research process differs. Biggs (1989) analysed participation of clients in research and came up with the following typology: contract, consultative, collaborative and collegial participation. Pretty adapted this typology and presented different types of research (see Table 2).

Table 2: Types of participatory research (Pretty, 1995, Biggs, 1989)

Designed by	Implemented by	Comments
Researcher	Researcher	On-farm trials and demonstration plots
Researcher	Farmer	Commonly called 'participatory' research
Farmer	Researcher	Very rare
Farmer	Farmer	Farmers' own research and experimental activities, rare in programmes

Daniels & Walker (1996) point out that forums comprising stakeholders to encourage mutual learning with the objective of solving problems and improve the situation are an essential aspect of collaborative learning strategies. In the knowledge system perspective, these forums have been called platforms (Röling and Jiggins, 1998). Steins (1999) argues that it should be up to the stakeholders what the desired outcome of a platform is, she continues that (ibid: 68)

> *"The emergent effect generated by interactions within the collectif is constructed by the platform itself and may take many shapes and forms."*

Ad 2. Social/ biological science mix

The social/biological science mix refers to the way in which biological and social sciences have been used in research. Issues of societal importance require both social and biological insights. This interdisciplinary encounter is increasingly referred to as the social/biological[15] science mix (Röling, 2000). Recently pure biological sciences increasingly include social sciences in their research process and analysis because they realise it is an essential condition for professionalism (Brussaard *et al.*, 2001). The social/biological science mix refers to such linkages across the biological and social domains.

In Actor Network Theory, two principles are employed (Callon and Law, 1989); these are (1) generalised agnosticism[16], which implies that a researcher should not take sides for either social or technological aspects of a study and (2) generalised symmetry. Generalised symmetry rejects that social science is only needed when natural science fails (often observed

15 We deliberately do not use beta (biological) and gamma (social) sciences because this distinction is not widely known and accepted outside of WUR.

16 Agnosticism means human beings cannot know everything about the cause of something (such as God or the reality).

when a technology is not accepted: rejection of a technology is often explained by social factors, and therefore social scientists are called in to solve the problem).

Collaboration between scientists is characterised according to the following typology (see Table 3).

Table 3: Defining disciplinarity

Collaboration	Explanation
Monodisciplinary	Research restricted to one research discipline. People within one discipline study the same research objects, use common methodologies and share the same paradigm.
Multidisciplinary	A variety of disciplines collaborate in one research program. Concepts, epistemologies, and methodologies are not integrated. Interaction between disciplines is restricted to linking research results.
Interdisciplinary	Collaboration between different disciplines. Concepts, methodologies and epistemologies are integrated.
Transdisciplinary first definition	Specific form of interdisciplinarity, boundaries between and beyond disciplines are transcended and knowledge and perspectives from different scientific disciplines and from outside research (such as farmers' knowledge) are integrated.
Transdisciplinary second definition	New form of learning and problem solving, involving cooperation among stakeholders in order to meet emerging challenges. Solutions arise through multiple stakeholder learning, and knowledge of all is enhanced.

Source: http://www.bio.vu.nl/vakgroepen/bens/HTML/ transdisciplinair.html

Ad 3. Democratisation of science

Funtowicz and Ravetz (1993) argue that post-normal science, in contrast to traditional problem-solving science, provides a path to the democratisation of science. In this type of science

> *"the evaluation of scientific inputs to decision-making requires an extended peer community." (ibid: 740)*

The relevant extended peer community not only involves the technically qualified researchers, direct producers, sponsors and users of the research, but all stakeholders who have a stake in the outcomes, the process and its implications. If a mutual respect for different perspectives exists, a democratic element can be built into science. The involvement of all stakeholders in the scientific process and outcomes provides an assurance for societal relevance. Hence, science requires new relations with the outside world: this is what Funtowicz and Ravetz (1993) have called a 'democratisation of science'. Lightfoot and Scheuermeier (2003: 70) state that

> *"Getting the 'right' research for sustainable agriculture and rural development means not only finding the 'right' research questions, but also the 'right' research partnerships between farmers, service providers and other relevant stakeholders".*

Getting to the 'right' research means finding more democratic ways to reach decisions. Funtowicz and Ravetz (1993) argue that a democratisation of science is an essential element for the effectiveness of science in meeting the new challenges of global environmental problems, i.e., issues of both high uncertainty and high stakes. Thus, democratisation of science concerns the way in which research becomes more democratic including the way in which choices are made. This involves new relations with intended beneficiaries, the process through which research goals are set, accountability of researchers towards resource-poor farmers, etc.

Ad 4. Context

The relevance of research to agricultural development is determined by the (global) vulnerability of local farmers. Farmers are primary decision-makers on a local level. However, their decisions depend on circumstances, larger institutions, social networks and market conditions. Therefore, not every agricultural innovation proposed by researchers is rational for African farmers. For example, if there is no infrastructure such as roads and markets, with production solely intended for home use, farmers do not have much interest in expanding production beyond self-sufficiency levels. It follows that it does not make sense to develop technologies for improved production when the products cannot be traded. Also, if cheap food imports with which African farmers cannot compete keep entering the country, it might not make sense to develop production-increasing methods (alone). Hence it is essential to take into account the context in which research processes and outcomes are embedded.

Pilot projects often artificially create more conducive conditions that allow farmers to use inputs, hybrid varieties, credit etc. Too often, the scaling-up or replication of these pilots fails once the artificial conditions are removed (Röling *et al.*, 2004).

Criteria for the expected outcomes of research

Exploring criteria for expected outcomes of research aim to build a perspective on a pathway for science that results in improved livelihoods for resource-poor farmers.

Conventional research, or research carried out within the positivist paradigm uses four criteria to judge whether science is trustworthy. Trustworthiness refers to the degree to which the quality of a research can be assured and judged. The criteria to judge trustworthiness in a positivist paradigm are:

a. *Internal validity.*
b. *External validity (results can be generalised).*
c. *Reliability (same result if repeated).*
d. *Objectivity (research is not influenced by the researcher).*

For this reason researchers generally build in control and replication in their experiments. These criteria are relevant for a positivist paradigm. In a constructivist paradigm the scientist is required to make the research plausible to society. Guba and Lincoln (2001) therefore developed four parallel criteria for trustworthy science:

a. *Credibility (to ensure subject of inquiry has been correctly identified and described, established by prolonged engagement at the site, persistent observation, peer debriefing, negative case analysis, progressive subjectivity and member checks).*
b. *Transferability (how far outside the observed domain results are applicable, that is findings are tested for localization rather than generalization).*
c. *Dependability (whether results will be similar unrelated to time, researcher and method through an inquiry audit).*
d. *Conformability (extent to which data can be traced back to their sources).*

However, the foundations of these criteria are also in the positivist paradigm (Shank, 1995; Guba and Lincoln, 2001). Pretty (1995) developed twelve criteria and procedures to judge whether a research is methodologically sound from a constructivist perception. His criteria are based upon Guba and Lincoln's (1989) criteria. With Pretty's criteria one can say that something is trustworthy because certain things happened during the research. The criteria and procedures are the following:

a. *Prolonged and/ or intense engagement of the various actors.*
b. *Persistent and parallel observations.*
c. *Triangulation of sources, methods and investigators.*
d. *Analysis and expression of difference.*
e. *Negative case analysis.*
f. *Peer checking.*
g. *Participant checking.*
h. *Reports with working hypotheses, contextual descriptions and visualisations.*
i. *Parallel investigations and team communications.*
j. *Reflexive journals.*
k. *Inquiry audit.*
l. *Impact on stakeholders' capacity to know and act.*

Pretty (1995) stresses there is only trustworthiness at a certain moment and in a given context.

The CoS programme argues that research also needs to serve a development goal: research has to benefit resource-poor farmers and improve their livelihoods. In the subsequent paragraphs five additional criteria for the expected outcomes of research are proposed. These are based on own experiences, desk study and, experiences and knowledge of prominent scientists in the CoS programme.

1: Linking research to opportunities

Often the focus of applied research depends on donor requirements and/or the preferences and specialisation of a researcher. Priorities for such research that are based on the specialist's background may not necessarily reflect contextual and farmers' priorities. Research is more likely to benefit resource-poor farmers if it is based on existing opportunities for research to improve resource-poor farmers' livelihoods. The challenge is to define and recognise those opportunities. Berg and Angstreich (2003) explain how dramatic yield increases that made Ethiopia a surplus producer resulted in catastrophic price falls due to a poorly developed domestic market and weak external linkages. They argue that genetically modified crops will not benefit countries such as Ethiopia if infrastructure and external linkages are not created. Hence, one should look at opportunities at a macro level to estimate whether a technology could be beneficial at all. Methods developed to link research to farmer's interest and opportunities are among others: Consensus Conferences (CEFIC 1997, Madden, 1994), Citizen Juries (Pimbert and Wakeford, 2002), Deliberative Opinion Polls (Madden, 1994, Anonymous, 1998, McLean *et al.*, 2000), Citizen Panels (Anonymous, 1998), Rapid Appraisal of Agricultural Knowledge Systems (Engel and Salomon, 1997), Network Theory Analysis (Leeuwis and Van den Ban, 2002), Stakeholder Analysis (Overseas Development Administration, 1995; Allen and Kilvington, 2001, Jiggins *et al.*, 2003), Target Group Analysis (Forster and Osterhaus, 1996), the Interactive Bottom Up Approach (Bunders, 1994, Broerse and Bunders, 1999), Livelihoods analysis (Mancini, 2006) and technographic studies (Richards, 2001). Technographic studies are deliberately designed to identify opportunities for innovation on a macro level. The main aim is to fit research in a broader frame. Opportunities, however, are perceived differently and constructed by diverse stakeholders (and 'are not just there') and therefore require the participation of all those concerned. From the above the first element for a pathway of science is proposed:

IDENTIFY RELEVANT OPPORTUNITIES FOR A RESEARCH CONTRIBUTION

2: Linking research to beneficiaries' needs

Technologies proposed by research are often not grounded in farmers' needs. For example, Degrande and Daguma (2000) in their study about the adoption of hedgerow inter-cropping in Cameroon noted that researchers had identified soil fertility as a major problem but farmers did not seem to perceive it as the most limiting factor. To prevent situations such as the one in Cameroon from occurring, several types of research approaches emerged such as: FSR (Collinson, 2000), Participatory Approaches (Chambers, 1990, 1997), FFS (Van de Fliert, 1993; Bruin and Meerman, 2001), PTD (Reijntjes *et al.*, 1992) and Interactive Prototyping (Vereijken, 1999). These methods have in common the intention to involve farmers in research and hence improve chances that research responds to farmers' needs and demands. A method that deliberately tries to ground research in farmers' needs is diagnostic exploration. A good example of diagnostic exploration is a study about pests in Bhutan (Van Schoubroeck, 1999; Van Schoubroeck and Leeuwis, 1999; Röling, personal communication, 2002). The researcher was told to do research on stem borers in maize. However, farmers were not interested because they felt they could not gain from it. Their interest was their mandarin trees, which suffered from fruit drop. The researcher was urged by the farmers to tackle the problem of mandarin flies. A second element is therefore:

GROUND RESEARCH IN NEEDS, CONDITIONS AND DEMANDS OF THE STAKEHOLDERS INVOLVED

3 and 4: Designing systems that work and are acceptable and appropriate to resource-poor farmers

Traditionally research is undertaken on-station where technologies are developed and tested (basic and applied research, see Figure 2). Once the technology proves satisfactory on the station, the technology is transferred to farmer's fields. However, all too often the technology does not give the same result under farmers' conditions as on-station. Reasons for this are, among others, the differences in soil quality, climatic conditions, water supply, weeds, theft, and availability of farm labour. In other words, conditions on-station with regard to location and access to resources such as labour and water on-station are different from those on the farm. For these reasons the development and testing of technologies is increasingly transferred from the station to farmers' fields (designing systems that work, see Figure 2). Mutsaers, *et al.* (1997) called this On-farm Research. When technologies are developed and tested on the farm chances are higher that they work under farmer conditions, for example, attention is paid to farmers' access to inputs and capital. Technology is defined as:

Box 1: **Farmers' conditions for experiments**

It is of utmost importance for farmers to have good quality seed for the next harvesting season. Farmers therefore decide how much risk is acceptable to them (although this might conflict with the paradigm of scientific research). No rational farmer would intentionally put her grain at risk. Artificial inoculation of grain with insect pests is therefore unacceptable to local farmers although such experiments might be justified in scientific terms. Björnsen Gurung (2003) explains that the scientific approach of comparing two storage systems that differed by only one factor was illogical to farmers. As farmers need the benefit rather than the proof (ibid), it is unacceptable to them that a part of the grain remains untreated although there is a control method that stands a chance of success. In the same vein, farmers felt uneasy to use two vessels of similar seize leaving half of the grain untreated. Hence, about half of the participants decided to make the control vessels very small to minimize the expected loss in untreated seed. Also, farmers would not agree to conduct experiments together or to use methods rendering them dependent on others.

> *"The application of organised knowledge to practical tasks by ordered systems and people and machines."* (Bunders, 1994: 12)

Even when a technology works on a farmer's field, this is not a guarantee that farmers will adopt it. Björnsen Gurung (2002, 2003) gives a good example of a technology that worked but was not adopted by local women farmers of Gobardiha, a Tharu village in Western Nepal. Björnsen Gurung (ibid) explains that rather than increasing the production, food security in Nepal can be improved through the protection of the food already produced.

Focus was therefore on seed protection. Scientists discovered that, to minimise seed loss, storage bins for seed should be opened and checked after 140 days of storage. If insects are observed in the storage bin, the seeds should be dried in the sun and can then be preserved until the end of the storage period (210 days). Farmers however did not want to follow this recommendation. They believe that the opening of vessels is harmful. Björnsen Gurung (2002: 145) points out that:

> *"Although invisible at first sight, storage practices and technologies are embedded in a system of magical and spiritual control."*

Therefore it was important to develop a technology that would be acceptable to farmers considering their religious and cultural beliefs. A way to monitor the commodity without opening the bin was developed. A piece of glass was inserted at the foot of the bin to allow monitoring from the outside. When the farmers observed insects through the window, they did not hesitate to remove the seeds and dry them in the sun. In case no insect activity was observed, opening was unnecessary. This improved bin did not only work but was also acceptable to the farmers. For some more examples from Björnsen Gurung's work of what is acceptable to farmers in the field of technology development see Box 1.

Another example of a technology that works under farmers' conditions but is not acceptable to farmers is the use of *Mucuna* for soil fertility improvement. In Southern Togo and Benin use of cover crops, especially *Mucuna* varieties, has been promoted for improved soil fertility[17] by a number of organisations among others, Sasakawa Global 2000, the International Institute for Soil Fertility Improvement (IFDC) and the International Institute for Tropical Agriculture (IITA). The technical merits of *Mucuna* for soil fertility improvement are extensively discussed (Buckles, *et al.*, 1998, Van Reuler, 1999) and it has been proven that *Mucuna* for soil fertility improvement is a technology that works and is profitable under farmers' conditions. According to Tarawali *et al.* (1999) *Mucuna* has been introduced in experimental stations in Nigeria since 1920 but, despite huge efforts to diffuse *Mucuna*, it has not been adopted on large scale. Deffo *et al.* (1999) studied the constraints of people in southern Togo for adopting a maize-*Mucuna* package (see Table 1). Resource-poor farmers cannot afford to let the land lie fallow since they only have limited land and labour available, it is not feasible for them to use their land and labour for a green manure crop such as *Mucuna*. Deffo *et al.* (ibid) found that the main reason why farmers do not use *Mucuna* is the land tenure insecurity.

17 Mucuna was mainly introduced to improve the nitrogen nutrition of the soil through fixing of atmospheric nitrogen. Mucuna, is also a cover crop improving the soil organic matter.

Table 1: Potential constraints to adoption of a maize - *Mucuna* - system and their relative importance in relation to land tenure (Deffo *et al.*,1999).

Constraint	Land owners	Land tenants
Availability of money or credit	4	6
Land tenure insecurity		5
Availability of Mucuna seeds	4	4
Maize marketing	3	
Storage facilities	1	3
Improved maize seed		2
Loss of second season		1

1-6 increasing degree of importance

The problem is that the effect of the maize-*Mucuna* system is long term and farmers are often only interested in short term benefits for the reasons explained above. According to Tarawali *et al.* (1999) focus should be on short-term benefits (such as weed suppression) rather than on long-term benefits in order to reach effective adoption. Indeed, in southern Benin suppression of spear grass (*Imperata cylindrica*) was a major reason for farmers to plant *Mucuna* rather than to grow *Mucuna* for soil fertility improvement (Manyong *et al.*, 1996). From the above, it becomes clear that for farmers additional motives, other than whether a technology works from a productivity point of view, determine impact. The technology should also be acceptable to the farmers. As stated in Figure 2 it becomes important to design 'acceptable and appropriate systems', technologies that are acceptable to the intended beneficiaries. However, farmers' conditions and their percpeptions about acceptability are not static. Conditions can change and research can even contribute to changing these conditions and perceptions. A third and fourth criteria for expected research outcomes are therefore:

DESIGN SYSTEMS THAT WORK UNDER FARMERS' CONDITIONS

DESIGN SYSTEMS THAT ARE ACCEPTABLE /

APPROPRIATE FOR THE BENEFICIARIES

5: Scaling-up

Scaling-up refers to increasing the impact of efforts beyond those farmers who were reached originally and beyond the duration of the project. It includes also the creation of institutional conditions to make it happen. Scaling-up is extensively discussed in the literature and diverse ways of classifying the efforts to increase the impact and scope of interventions are proposed (DeJong, 2001, Harrington *et al.*, 2000, Lovell *et al.*, 2000, Edwards and Hulme, 1992, Myers, 1984). Our comprehension about scaling-up is similar to Uvin and Millar's (1994) later refined by Uvin *et al.* (2000), who state that scaling-up refers to an increase in size, complexity, impact and interaction. In our vision scaling-up is not about the technologies that are scaled-up, but rather about the processes and principles leading to the application of technologies or innovative performances. We propose the following typology (adapted from Uvin and Millar, 1994 and Uvin *et al.*, 2000) for scaling-up:

1. *Quantitative scaling-up[18] refers to expanding in coverage and size through increasing the number of people involved and as a result an increased geographical area or budget. Different paths or processes to reach such quantitative scaling up are aggregation, replication (not duplication), and integration. This is the most widely shared vision on scaling-up. Such scaling-up sometimes is an autonomous process by which the efforts from research and extension (e.g., technologies and innovations) are multiplied across a large number of spontaneous adopters, and is then called diffusion (Rogers, 1995).*
2. *Functional scaling-up, when number and types of activities are added to the operational range. This can both refer to diversification and adding up or downstream activities. Farmers spontaneously might adapt practices to other crops for example.*
3. *Institutional scaling-up[19], i.e., development of relations and interaction with the public and private organizations at different levels. This necessitates a shared objective, for example governmental services and resource-poor farmers do not automatically share the same objective[20].*
4. *Organizational scaling-up, i.e., improving the effectiveness and efficiency of activities. The end result of organizational scaling-up is enhancing increased sustainability.*

18 Fisher (1993) calls this scaling out.

19 Uvin and Millar (1994) refer to this type as political scaling-up. However, to stress the role of institutions we refer to it as institutional scaling-up. Institutional scaling-up supposes that what is rational for the originator is (or becomes) also rational for collaborating organisations.

20 And this in its turn implies that up institutional scaling-up is not a politically neutral process but is rather based on deliberate choices. Also, it often leads to empowerment of resource-poor farmers as the IPM FFS movement in Indonesia has shown us, for example.

These are of course no exclusive categories. An activity that increases in coverage does not necessarily increase in impact on people's livelihoods; therefore increasing coverage is insufficient as an attempt to scale-up. Similarly, solely a diversification of activities might drive us away from the initial objective. Scaling-up most often is a combination or mix of these analytical types of scaling-up. Scaling-up is a process that requires a specific mix of interventions depending on situation, location, policies, people etc. Scaling-up is therefore dynamic and as a result research activities and processes need to allow for flexibility and adjustment to changed objectives. Even though it might be considered acceptable that some distinctiveness is lost in the process of scaling-up, the objective should not be lost. Yet, it shall be recognised that some initiatives might be viable precisely because they are small (Samoff and Sebatane, 2001). Authors commonly agree that the feasibility of scaling-up depends on whether or not the activity is founded in policy support and in the presence of dedicated leadership, partnerships and networks providing the infrastructure on which to build expansion, including strong demand from communities, and funding availability (Smith and Colvin, 2000; Samoff and Sebatane, 2001). The fifth element is therefore:

RESEARCH DESIGNS SYSTEMS THAT CAN BE SCALED UP

Concluding remarks: An initial perspective on a pathway for science impact

In this chapter the major issues for agricultural research to be beneficial to resource-poor farmers were identified. Crosscutting issues are the following:

1. *Different stakeholders engage in a learning process as the key to interactive research.*
2. *To gain understanding of important societal issues, insights of an inter-disciplinary nature are required.*
3. *Intended beneficiaries and stakeholders have increased influence on the design, implementation and impact of the research through a democratisation of science.*
4. *The context in which farmers operate influences their practices.*

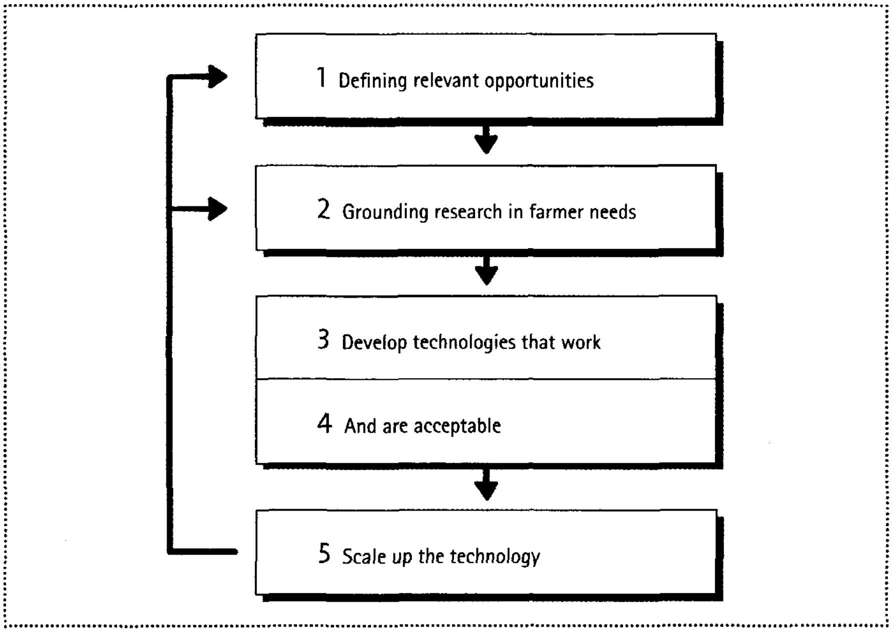

Figure 3: An initial perspective on a pathway for science impact

Based on the previous sections, criteria for useful research for resource-poor farmers proposed are the following: (1) identifying opportunities for research to make a contribution, (2) grounding research in beneficiaries' needs, (3) developing technologies that work in local conditions, and (4) are acceptable and appropriate to intended beneficiaries. This technology can now be (5) scaled up. See Figure 3 for the relationships between these criteria.

The framework will be used as a first perspective to look at research projects to further explore the third research question presented in the first chapter:

> *What additional criteria does formal agricultural research have to meet so as to ensure that the research benefits resource-poor West African farmers?*

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CHAPTER 3

Methodology: Learning our way towards a pathway for useful agricultural research

In this chapter we discuss the conditions in West Africa that impact on research. Then the methodology used to collect the information is explained. In the annex we will briefly present the research area (annex II) and the stakeholders, in particular the PhD researchers in the CoS programme and the topics of their interest (annex I and III). We also discuss some limitations of the current study.

Specific conditions in West-Africa to which research needs to be adapted

What are the specific conditions in West-Africa to which research needs to adapt such as climatic conditions, political setting, infrastructure etc.?

According to the Inter Academy Council (2004) unique features of African agriculture include the following:

- *Lack of dominant farming systems on which food security largely depends.*
- *Heterogeneity and diversity of farming systems and the importance of livestock.*
- *Predominance of rain-fed agriculture as opposed to irrigated agriculture.*
- *Dominance of weathered soils of poor inherent fertility.*
- *Key roles of women in agriculture and in ensuring household food security. Women are increasingly responsible for agriculture, partly due to (temporary) migration of man for labour to the cities (i.e., feminisation of agriculture).*
- *Lack of functioning competitive markets. In addition, requirements of the world market ('clean food') change desirable production methods and hence place other demands on research intervention.*
- *Under-investment in agricultural Research and Development and infrastructure.*
- *Lack of conducive economic and political enabling environments.*
- *Large and growing impact of human health on agriculture (e.g., AIDS).*
- *Low and stagnant labour productivity and minimal mechanisation.*
- *Predominance of customary land tenure.*

Resource-poor farmers have been very innovative in adapting to these features (e.g., Mazzucato and Niemeyer, 2000). Röling *et al.* (2004) discuss three main causes why research has not been able to link up to these conditions.

The first is the lack of countervailing power of West African farmers over research. In the industrialized world research is much more oriented towards farmers' needs because strong farmer-based organisations represent farmers' interests and these farmer-based organisations negotiate with other stakeholders to ensure that the research conducted meets farmers' needs. This way, technology development is demand-driven, at least in the majority of cases. Conversely, in West Africa, farmers' organisations are a newer phenomena and their countervailing power is not yet strong enough to significantly influence the research agenda. West African farmers also differ from their counterparts in the industrialised world with respect to heterogeneity of land use and the institutional and natural resources context.

The second is the lack of markets and service institutions. It is simply not beneficial for resource-poor farmers to increase their production when cheaper (imported) products are available. Nederlof and Dangbégnon (in press) describe how resource-poor farmers are not interested in increasing their production because they cannot sell the surpluses (and additional production only decreases the prices even more). Röling *et al.* (2004: 218) explain how farmers are constrained by the lack of institutions at the middle level, such as veterinary health services, credit provision, input delivery mechanisms, extension services and transport.

The third cause is that governments cream off farmers' wealth diminishing farmers' interest to innovate. The government can afford to fix any price for farmers' produce. Recently, however, opportunities in certain sectors have increased and governments offered farmers better prices, such as for cocoa (e.g., Ayenor *et al.*, 2004, Dormon *et al.*, 2004).

A fourth cause is the inappropriate research process (see Chapter 1 and 2). Given that the present dissertation does not have the means to change anything in terms of the first three causes; its focus is on the research processes. By suggesting criteria for improving the research process attention will be drawn to the first three causes. It goes without saying, therefore, that changing the research processes is an essential yet not sufficient condition to improve the impact of agricultural research on the livelihoods of resource-poor farmers. The first three causes mould framework conditions that research largely has to take for granted. When these framework conditions are unfavourable for agricultural development, research can only make a limited contribution.

Research methodology

The research methodology for this dissertation is based on four pillars:

1. *The study is explorative in character. The main aim of this research is to explore some elements and features of research that have an impact on the livelihoods of resource-poor farmers. It focuses on qualitative rather than quantitative issues, and there is no predetermined hypothesis; rather the research focus evolves while in progress (see also Lee, 2002). As a result, the study objects are chosen for their informative value, rather than for their potential to provide statistical rigour.*

2. *The dissertation is based on a multiple case study methodology. Examples of agricultural research are studied and the characteristics of those examples are intensively investigated. It also incorporates the views of different 'actors' (and as such is democratic because it gives a voice to all stakeholders) giving special attention to observation, reconstruction and analysis (Tellis, 1997). A weakness of a case study approach is that it is difficult to generalise conclusions. However, the goal of a (our) case study design is to explore a situation of agricultural research and to determine parameters of success and failure. Each case study followed the same methodological principles for data collection. Yin (1994) explains that a multiple case study design must follow replication rather than random sampling. A case study design is based on triangulation (of methods, sources of data and informants) to reduce subjectivity of the researcher as much as possible. We chose for a case study methodology because it is flexible (e.g., several cases can be studied at the same time, and additional cases can be selected if needed) and allows reporting on different aspects of a situation (e.g., selection of farmers, research process and methodology, multi-stakeholder negotiation, participatory technology development, etc). Also, the aim of our research is to explore criteria for the impact of agricultural research on rural people's livelihoods, rather than to have a quantitative representative sample.*

3. *By comparing agricultural research experiences in the case studies, common principles and similarities of issues impacting on the usefulness of agricultural research are deducted and understood. The risk of comparison is that the specificities and uniqueness of each case is lost. However, since each case within the Convergence of Sciences (CoS) programme is reported on separately (Dormon, in press, Ayenor, in press, Sinzogan, in press, Vissoh, in press, Adjei-Nsiah, in press, Saïdou, in press, Kudadjie, in press, Zannou, in press) and independently of the researcher of this dissertation, this does not seem a problem.*

4. *The results reported in this dissertation are very much the outcome from a collective and collaborative effort. It is only because my colleague PhD researchers allowed me an inside look into their research design, processes and fieldwork and to share their thoughts and results with me, that I was able to take a Meta perspective and better understand the different factors that impact on a research design. Also, the analysis of the research sequence on the basis of a number of themes was discussed during PhD researcher meetings and validated during workshops. Hence, all steps of this dissertation (i.e., the first and third block) were done together and in consultation with my colleagues, and my role was to facilitate the debate, and report and structure the findings.*

My own role in the research

My main role within the research was that of an *observer and analyst of the entire programme*, i.e., my role is at a Meta level. I tried to obtain an overall picture of what happened, identify common principles and understand the collective outcome. This includes the learning process of a group of scientists from different disciplines and the negotiation about such common principles as the research sequence and methods. One researcher described me as the anthropologist of the programme (Richards, personal communication).

In addition, I *participated* in the whole programme through discussions with the PhD researchers and their supervisors, both individually and in-group, providing ideas during workshops and fieldwork trips. I therefore also contributed to the creation of, amongst others, common principles. Also, I presented my research outcomes during workshops. I therefore gave my colleagues an opportunity to participate in my work as well. Hence, I not only looked at the CoS programme but was also part of it.

In the case studies beyond the CoS programme (i.e., the projects already completed that are reported in Block II), I was an *observer* of the impact of the project *and an analyst of its outcomes.*

Discussing the three steps

The research has been conducted following three steps: first the analytical framework was constructed, then the framework was fine-tuned on the basis of two case studies of completed research projects in West Africa and as a third step the experiences of the CoS programme are analysed using the framework. The methodology used for each of these steps is discussed below. More details are provided in the respective chapters which have, in a number of cases, been published as stand-alone papers and therefore contain a full methodological account.

A process approach guided the research (see Figure 1), meaning that the agenda was set each time the stakeholders of the CoS Programme met. There was not a blueprint for the programme from the start onwards. Actions and activities took shape gradually and emerged as a result of a negotiation process. The disadvantage of such an approach is that a template for the programme activities does not exist and hence it is difficult to evaluate the outcome from an initial set of objectives. The advantage of such an approach is that it is dynamic and based on learning. The process-driven approach is also intrinsic to this dissertation.

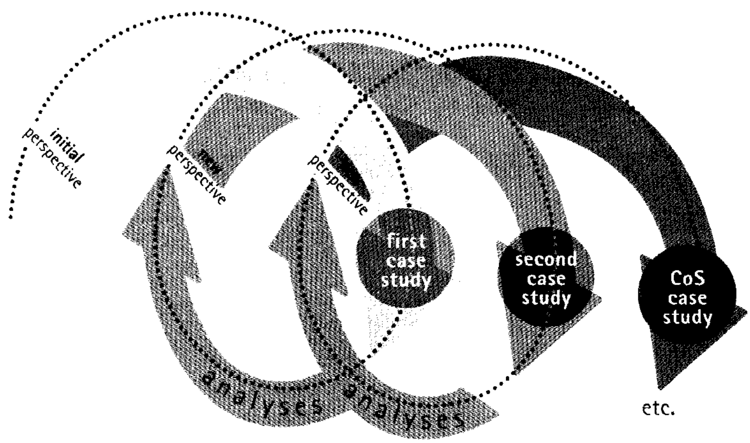

Figure 1: Cyclical approach to case study design

Developing an initial framework

In the first and second chapters, we developed an initial analytical framework to analyse agricultural research.

As a first step towards an initial analytical framework a first set of criteria for useful research is proposed. These criteria were based on, 1, recent doctoral work (Van Schoubroeck, 1999; Tekelenburg, 2001; Lee, 2002 and Baars, 2002) and 2, expertise and experiences of a number of prominent scientists and researchers collaborating in the CoS programme. The main method used to develop the framework was a desk study on research approaches coupled with semi-structured interviews and informal exchanges with key scientists.

To further construct and deconstruct the initial analytical framework the following types of sessions, making use of participatory tools, were organised: (1) brainstorming sessions with scientists to identify factors impacting on criteria for useful research for resource-poor farmers, (2) workshops to construct and adjust the proposed framework from the point of view of field experiences, and (3) discussion sessions, both face-to-face and in a group, to discuss the underlying principles, structure and usefulness of the framework.

The framework is therefore the result of a co-construction of knowledge. In this sense, the study also has a 'grounded theory' element in that interaction with the empiry and the views of others is used to generate useful insights into effective agricultural research.
Grounded theory implies that theory does not come from outside, but arises from the data. Grounded theory is process-oriented and has two basic principles: (1) research is based on a

constant comparison and (2) on theoretical sampling; this is the process of deciding which additional data are required to further develop theory (Glaser and Strauss, 1967). We are actively involved in the research process, following Strauss and Corbin (1994). The situation where a researcher is engaged in the inquiry process is called Sensitive Methodology (Knorr-Cetina, 1981). To enable a study on the research processes conducted we follow the actors, in this case the PhD researchers.

Improving the framework

Our case selection process at the start of the field work period commenced with conducting an exploratory study in West Africa to identify interesting initiatives or innovative research projects that could serve as a case study to fine tune the analytical framework. Very diverse projects were visited such as several Farmer Field School Projects, a church agricultural network, university projects and Non Governmental Organisations (NGO) projects. Two projects, a soil fertility project with two rural communities and a regional FFS project were selected not at random but purposively on the basis of the following criteria (applied as impartially as possible):

1. *Activity has ended, so a complete overview of the results could be obtained.*
2. *Several stakeholders were involved.*
3. *Both social and biological insights were applied.*
4. *Initiative appears innovative (e.g., based on interactive science and facilitation).*
5. *Practical considerations, such as accessibility of the project site and project staff willing to collaborate and provide information.*

For each of the case studies we first conducted a literature review and complemented this information by interviewing project stakeholders. Details are provided in relevant chapters (Chapter 4 and 5).

Analysing the framework through CoS research activities

The analytical framework improved after analysing the cases beyond CoS was used to analyse the CoS experiences. As discussed in the first chapter CoS followed several steps:

1. *Technographic studies to identify opportunities on a macro-level. Because the results were only partly documented (Project COS, 2004) we did not conduct a comparative analysis of the technographic studies. Also issues of ownership (e.g. some researchers who carried out the technographic studies have not published the results) and methodological constraints (e.g. some parts of technographic studies were not carried out) motivated this choice.*

2. *The eight Diagnostic studies carried out by the CoS PhD researchers. These are compared in Chapter 6 (Nederlof et al., 2004)*

3. *Conducting experiments with farmers. These experiments are compared in Chapter 7.*

4. *Scaling up research results. Even though some PhD researchers engaged in creating social space for technology (Dormon, in press, Ayenor, in press, Sinzogan, in press), scaling-up will be the main focus of the proposed second phase of the CoS programme and therefore will not be discussed in this dissertation.*

Whereas step one was conducted by some scientists involved in the CoS programme, steps two and three were conducted by the eight CoS PhD researchers. We will first introduce these PhD researchers, their topics and background and the experiments they conduct with farmers. The specific methods used for the comparative analysis of the different research steps within CoS are presented in the chapters concerned (Chapter 6 and 7).

The PhD researchers are the pillars of the CoS programme. Reasons for this choice are (Van Huis, personal communication April 2004): (1) PhD researchers are motivated to conduct and finish the work, and (2) PhD researchers are cheaper than consultants. In addition, one builds a base for further development through capacity building. The research would be conducted in Ghana and Benin and as a result the PhD researchers were selected from these two countries.

Four PhD researchers were selected with a biological science background and the other four from a social science background (see Annex III), they subscribed to respectively the social-oriented Research School for resource Studies for development (CERES) and the more biological-oriented Production Ecology & Resource Conservation (PE&RC) of the Wageningen University.

PhD researchers having attended both a technical and a social training either at the BSc or MSc level were considered 'social scientists' (Table 1). All natural scientists have both a biological BSc and MSc.

As a result of the technographic studies, the diagnostic studies and their own personal interests, the PhD researchers were assigned different topics (see annex I). Actually, the type of crop (e.g., cash, private or grassroots) and the theme resulted largely from the technographic studies. A match was sought with the interest of the PhD researchers for topics identified during the technographic studies. Further details of the themes chosen were a result of the diagnostic studies and as such grounded in farmers' needs, in the personal interests of the PhD researcher and in the supervisors' concerns (see for further details

Chapter 6 on diagnostic studies). To underline the two principles[21] of the CoS programme, both social and biological, and African and European supervisors were assigned to the PhD researchers. The exact allocation is given in Annex I.

All PhD researchers were supervised by a relatively large group of supervisors from diverse background and with divergent ideas. This had implications for the work, since PhD researchers were constantly confronted with a number of divergent views and expectations.

Limitations of my study

The first set of limitations of this study is related to my own position within the CoS programme:

- *Looked at other PhD researchers' research results at a time when they had not yet completed their studies.*
- *Although collective learning was intended in CoS, competition between PhD researchers played a role, leading to some protectiveness with respect to their data. The presentations during CoS workshops might unintentionally have enhanced competition.*
- *The principal researcher is a white woman from another culture, which has both pros (people more easily confine certain issues to an outsider/ it is easier to ask questions others cannot because we are not expected to understand everything) and cons (takes more time to understand relations/disagreements between people and other subtle messages given through cultural codes).*
- *We are comparing research processes; some PhD researchers feared that such a comparison inevitably would lead to evaluating research outcomes.*
- *Some PhD researchers felt pressure to develop useful technologies rather than explaining that some technologies were not useful and analysing reasons for this.*
- *Some PhD researchers prefer publishing their results before exchanging with me.*
- *I am part of the CoS programme and not an independent outsider.*

Another limitation of the study is that the study is on-going and hence no ex-post analysis is possible to determine the long-term impact of the research process on farmers' innova-

21 As a reminder we copy the following from the first chapter of the present dissertation: CoS is based on two main principles, which in turn are based upon lessons drawn from previous research projects. The principles are the following:
1: Convergence between scientific and local farmers' knowledge. The programme aims to enhance the role of various stakeholders in research and in particular those of farmers: a democratisation of science.
2: Convergence between biological and social scientists. This because the focus will be, not only on yield increase, but also on socio-economical and cultural innovation. CoS explores possibilities for an effective social-biological encounter.

tive performance. Also, all dissertations had the same deadline, to allow for a common defence ceremony. The disadvantage was hence that I could not use the completed write-ups of my colleagues for analysis.

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BLOCK 2

IMPROVING THE ANALYTICAL FRAMEWORK THROUGH A COMPARATIVE CASE STUDY ANALYSIS

CHAPTER 4

Lessons from an experiential learning process: The Case of Cowpea Farmer Field Schools in Ghana

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Abstract

The Farmer Field School (FFS) is a form of adult education using experiential learning methods, aimed at building farmers' decision-making capacity and expertise. The National Research Institute in West Africa conducted FFS in cowpea cultivation and we use this experience to analyse the implementation of the FFS approach. How does it work in practice? The curriculum deployed is compared to the 'principles' for FFS curricula. We assessed the impact of the FFS on the implementation process of Integrated Pest Management (IPM) practices in farmers' crop management. The appreciation of different stakeholders is also recorded. The analysis shows that the FFS was used as a tool to transfer messages, rather than to foster experiential learning among farmers. The article seeks to analyse the reasons for this shift in objectives and concludes that the way in which the FFS approach was applied in the case of the cowpea project did not allow optimal benefits to be derived from IPM practices.

Keywords

Adult education, case study analysis, farmers' livelihoods, Integrated Pest Management, resource-poor farmers, West Africa

Introduction

Although agricultural research and development (R&D) in West Africa aim to improve the livelihoods of resource-poor farmers, the intended beneficiaries are often too poorly organised and consequently have too little political clout to influence the R&D agenda. The authors are not aware of farmers in West Africa funding agricultural R&D projects; this in contrast to farmers in Northern America and Europe[22]. Therefore, West African farmers are not part of decisions about R&D. Participatory methods only partly improve this situation. Among these methods to identify farmers' needs and compensate for the lack of countervailing power of farmer organisations are Farming Systems Research (Collinson, 2000), Participatory Rural Appraisal (Chambers, 1990) and Participatory Technology Development (Reijntjes *et al.*, 1992). Another, more recent, approach developed to achieve these purposes is the Farmer Field School (FFS). FFSs are season-long platforms which accommodate field-based groups of approximately 25 to 30 farmers, who meet regularly to learn together through discovery and experience. FFSs are intended to allow convergence between local and scientific knowledge and aim to make farmers better decision-makers. Whereas the conventional 'transfer of technology' approach focused primarily on 'the best technical means' and on transferring these to farmers, the FFSs approach belongs to another paradigm oriented towards helping farmers become better decision-makers and towards developing or adapting technologies that work and also are acceptable to farmers (see also Nederlof *et al.*, 2004; Röling, 2002; Röling *et al.*, 2004). FFSs purposely aim to develop farmers into more knowledgeable and empowered partners, or co-producers of knowledge. What can we learn from the analysis of the implementation of such an approach in a specific situation?

This article discusses cowpea FFSs. The cowpea FFSs in Northern Ghana were conducted by the National Research Institute (NRI) and supported by different donors and programs to introduce Integrated Pest Management (IPM) strategies. Now that the project has come to an end, it provides an interesting case to study an attempt to implement FFS. What problems occur when using an experiential learning approach? How do researchers perceive farmers and knowledge generation? Do farmers become better decision-makers? This article tries to analyse FFS implementation as an interactive multiple stakeholder process. Scientists have tried to work in an interactive way with farmers. How did this work out? What can we learn from experiences with such a method?

First the literature is reviewed to better understand the concept of FFS and the role of cowpea in the farming system. Next, the cowpea FFS project is introduced. The article

22 See for example http://www.milk.org

then presents the methodology for data collection for the study reported in this article. The analysis compares the development of the curriculum with the 'principles' of FFS curricula. To evaluate the impact of the cowpea FFS, the study looked into farmers' implementation process of IPM practices and assessed the appreciation of the FFS approach by different stakeholders, e.g., researchers, extension workers/facilitators and farmers. The results of our study motivated a further analysis of the process by which the curriculum for the cowpea FFS was developed and the role of researchers in this process. The article concludes by drawing some general lessons.

Farmer Field Schools reviewed

Farmer Field School

FFS were originally developed in Indonesia in the late eighties as an approach to IPM learning (Van de Fliert, 1993)[23]. IPM was a reaction to second-generation problems of the Green Revolution, such as pesticide resistance, pest resurgence, and secondary pest outbreaks. The development of FFSs as a methodological approach to IPM resulted from the failure of teaching IPM through top-down extension methods. In an IPM FFS, farmers meet regularly -generally once a week- during a cropping season. The key ingredients of a FFS are a group of about 25 to 30 farmers with a common interest, a field and a facilitator. The facilitator, often an extension agent who has received a Training of Trainers (ToT) but increasingly often a farmer trainer, focuses on both the process to provide learning opportunities and the content to explain the principles of IPM. Yet, the facilitator asks questions rather than provides answers. The farmers analyse the conditions of the crop in several fields: one in which they apply conventional cultivation methods and one in which IPM methods are followed. Often there is a third field for participatory experiments. Farmers discuss the results of the analysis of the condition of the crop and draw conclusions about the management of the IPM field (ibid). The FFS approach assumes that farmers experiment as experts, learn systematically, and value their own knowledge (van den Berg *et al.*, 2001). FFSs aim at farmer *education* and differ from the conventional practice of transferring technology through extension. It is not a question of 'delivering' science-based technology to 'ultimate users'. In FFSs, farmers learn to draw reasoned conclusions from their own observations. Thus they learn principles and practices that they can apply in diverse conditions. The ultimate aim of FFSs is not to carry out scientific research, but the FFS is science-informed (Röling and Van de Fliert, 1998): the experiential learning by farmers is guided by a curriculum which is often interactive in that it is based on scientific and farmer

23 IPM is the technical/ ecological approach to pest management and FFS is the methodological approach to farmer experiential learning.

knowledge. The FFS often develops into a support group so that participants can support one another even after the FFS is over (Gallagher, 1999).

Many FFSs beyond the scope of IPM have been established, following Indonesia's success example: FFSs are applied in a variety of circumstances and for a variety of objectives (Bruin and Meerman, 2001; CIP-UPWARD, 2003; LEISA, 2003; Pontius *et al.*, 2002). Common principles of IPM are (Van de Fliert, 1993):

1. *Grow a healthy crop;*
2. *Observe the field weekly;*
3. *Build on natural processes and*
4. *Farmers become (IPM) experts.*

The Key Principles of Farmer Field Schools are (Pretty, 1995: 256):

a. *What is relevant and meaningful is decided by the learner, and must be discovered by the learner. Learning flourishes in a situation in which teaching is seen as a facilitating process that assists people to explore and discover the personal meaning of events for them.*

b. *Learning is a consequence of experience. People become responsible when they have assumed responsibility and experienced success.*

c. *Co-operative approaches are enabling. As people invest in collaborative group approaches, they develop a better sense of their own worth.*

d. *Learning is an evolutionary process, and is characterised by free and open communication, confrontation, acceptance, respect and the right to make mistakes.*

Box 1: **Non-negotiables in FFS (according to CIP-UPWARD, 2003)**

- *Farmer-centred*
- *Competent facilitators*
- *Curriculum development*
  - *Topics chosen by community*
  - *Training based on farmers' knowledge*
  - *Training based on farmers' needs*
  - *Participants involved in curriculum development*
- *Systematic training process*
  - *Observation*
  - *Group discussion and analysis*
  - *Conclusions and action plans*
  - *Agro-Ecosystem Analysis (AESA)*
  - *Regular and frequent meetings*
- *Education principles*
  - *Skill, not information is the goal*
  - *Discovery learning*
  - *Learning by doing*
  - *Science-based*
  - *Experiential/ problem-based learning*
  - *Experimentation and study plot*
  - *Non-formal education process*

e. *Each person's experience of reality is unique. As they become more aware of how they learn and solve problems, they can refine and modify their own styles of learning and action.*

During a CIP-UPWARD[24] workshop the non-negotiables for FFS were identified (see box 1).

Whereas many studies highlight the positive impact of FFS on such criteria as reduced pesticide use and increased yields (van de Berg, 2003), others argue that pesticide use has not significantly decreased nor yields increased (Feder *et al.*, 2003). Feder *et al.* (ibid) also state that FFS are expensive and therefore unsustainable. Indeed, compared to the conventional 'transfer of technology' approach, the costs of the FFS approach per farmer reached seem high. Others do not agree with this criticism (Regional Seminar on IPM Impact Assessment, 2003; Global IPM Facility, 2003; Mancini, 2006). They argue, for example, that the cost of ineffective extension even if the extension worker might talk to more farmers per unit of time is always higher than an effective FFS.

Whether the FFS is seen as an experiential learning approach based on principles of adult education, or as a method to transfer technology, depends on the goals that the observer ascribes to FFS and the value given to that goal. Economists who see technology as the driver of economic growth tend to emphasise the importance of technology transfer (e.g., Feder *et al.*, 2003), while others give more emphasis to farmer empowerment and their ability to experiment and take effective decisions (e.g., Röling, 2002). In this article, we consider FFSs as an experiential learning approach. FFSs are a method to empower and capacitate farmers through experiential learning, farmer research and experimentation, and have an impact beyond 'transferring technologies that work' (e.g. on experimental fields of research stations) to farmers. Some of the major differences between "Transfer of Technology" and "Experiential learning" are listed in Table 1.

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24 CIP stands for 'International Potato Center' and UPWARD stands for 'Users' Perspectives with Agricultural Research and Development'. UPWARD is a partnership program of the CIP that supports Asia-wide networking on participatory research and development for sustainable agricultural livelihoods. For more information see: http://www.cip-upward.org/main/CMS_Page.asp?PageID=1

Table 1: Principles of Transfer of Technology and Experiential Learning

Issue	Transfer of Technology	Experiential Learning
Trainer	Extension worker (Training and Visit)	Facilitator (adult education)
Role of farmer	Receiver of 'new technology'/ end-user	Co-learner/ expert
Role of research	Primary source of information	Process and consequence of local testing and farmer learning/ input in curriculum
Learning	Individual acceptance of technologies	Group learning based on observations and experiments. Decision-making process more important than the decision per se.
Curriculum • Topic • Knowledge • Needs • Participants involved	• Chosen by scientists/ extension workers • Science-based • Based on scientists' perspective • Developed by scientists	• Chosen by community • Based on local knowledge and situation, • Based on farmers' perspective • Negotiated with farmers
Locus of expertise	Researcher/ Extension worker	Farmer
Decision-making	Application of recommendations	Locality specific decisions based on observations
Pedagogy	Training (demonstrations and field examples)	Experiences, Education (learning cycle)
Training site	Demonstration field, training centre, home of Contact farmers	Collective field

Source: Adapted from Gallagher (1999), van de Fliert *et al.* (1995), CIP-UPWARD (2003), and Dilts (1998)

Through the FFS, farmers become better partners for researchers and extension workers. The difficulty often is for extension workers to become facilitators and not to fall back on the 'transfer of technology' approach in which they are usually trained and to "order" farmers what to do. Measuring success of FFSs in terms of adult education requires additional parameters such as the quality of produce, marketability, agricultural sustainability, policy effects, gender effects, farmer-to-farmer diffusion, education and empowerment effects (van de Berg, 2003).

The role of the curriculum in Farmer Field Schools

FFSs are usually conducted on a common plot in the proximity of the community, rather than on several individual farmers' plots, so as to allow for collective decision-making and discovery. A collective field stimulates discussion, and responsibilities about the management of the plot are taken jointly by the participating farmers.

The plot is divided in a *farmers' practices* plot, on which farmers cultivate in their traditional way, and plots on which farmers apply IPM as a set of relatively ecologically friendly practices. These plots are the main tools for farmer education and allow for comparison of practices. Differences between farmers' practices and the introduced IPM practices are easily observed and interpreted. Care must be taken to ensure that farmers do not start using the novel practices on the 'farmers' practices' plot once they become convinced of the usefulness of the new practices. In order for the plots to remain comparative also for fellow villagers, the 'farmers' practices' must be carefully negotiated and agreed upon from the start.

FFS have a flexible curriculum for experiential learning. Standard components of a FFS approach are insect zoos, Agro Eco System Analysis (AESA), special topics and group dynamic exercises (see also van de Fliert *et al.*, 1995 and *http://www.fao.org/documents/show_cdr.asp? url_file=/docrep/005/ac834e/ac834e05.htm*):

- *Insect zoos allow identification of (living) natural enemies and observation of their action against insect pests. In this way farmers become aware of food-web relationships in their agro-ecosystems.*
- *AESA consists of a series of observations of smaller groups of farmers on the subject in the field on both the farmers' practices and the IPM practices plot and a structured analysis leading to a discussion about the findings to make decision about what needs to be done on the crop in the week following the FFS session. AESA stimulates deliberation between farmers and as such reinforces informed decision-making. Youdeowei (2002: 16) explains that:*

> *"AESA is based on a process of making observations in the environment wherecrops are growing, analysing the findings, and, based on these findings, making decisions about appropriate crop management actions to take at the time. This tool is location-specific. This means that the action applies only to the particular pest or disease problem identified at that particular location at the time of the observations and decision."*

For more details about the steps involved in conducting an AESA see Youdeowei (ibid).

- *Special topics are topics not covered during the field activities. The curriculum often proposes a range of special topics from which the farmers of a particular FFS group can chose. They include subjects such as seed selection, post-harvesting handling and storage methods, soil management, farm record keeping and economic analysis.*
- *The FFS often includes a group dynamics exercise to help farmers become more aware of group processes, the value of co-operation, etc.*

From this literature review some pertinent questions and study areas emerge, which we aim to address in this article:

1. *How was the curriculum for cowpea FFSs in the project developed and implemented?*
2. *How was the implementation process of Integrated Pest Management (IPM) practices in farmers' crop management influenced by FFS?*
3. *How did the different stakeholders appreciate FFSs?*
4. *What are problems emerging with implementing this interactive approach, and consequently what lessons can be drawn?*

Case study Cowpea FFS project

The role of cowpea in the farming system

Based on both literature and interviews with stakeholders we conclude that cowpea[25], which has a high protein content, is an important food crop in West and Central Africa. It is a multiple purpose crop: leaves, pods, peas and grains are used for food; the remainder of the plant serves as an animal fodder during the dry season. In addition, some cowpea cultivars have beneficial effects on soil fertility and weed reduction because of this species' good soil cover, its atmospheric nitrogen-fixing abilities, and its impact on organic matter content. Cowpea is often intercropped[26] with sorghum or maize and tolerates drought, but is very susceptible to damage by insect pests, diseases, and parasitic weeds. Cowpea has benefited from limited research interventions (FIDA, 2000) compared to other cash crops.

In Ghana, cowpea is mainly cultivated in the Northern, Upper East and Upper West regions. The rains in these regions fall between May and October with an average annual rainfall between 900 and 1100 mm (PEDUNE project, 2000). The cowpea seasons are from April to

25 The scientific name is Vigna unguiculata [L.] Walp.

26 Coulibaly and Lowenberg DeBoer (2000) state that cowpea mono-cropping increases proportionally to the crop's economic importance. Farmers later explained that they prefer intercropping of their local varieties and mono-cropping of the improved varieties.

July and from July to October. Cowpea is therefore the first crop to be harvested in that part of the country and bridges the 'hunger gap' between two rainy seasons.

Farmers in our study listed the following problems in cowpea production in order of their relative importance during the participatory appraisal: lack of labour to cultivate it in a proper manner, low prices for the produce, limited access to markets, difficulties to store the produce due to pests (cowpea storage weevil), pests during cultivation (such as aphids, flower thrips, pod borers and sucking bugs) and diseases (such as wilts and anthracnose), danger of snake infested fields, difficulty to reach the bush plots (where cowpea is usually cultivated) and difficulty of transporting the produce to the market. To manage cowpea pests, farmers routinely use synthetic pesticides, mainly the pyrethroid insecticide *lambda-cyhalothrin* (PRONAF project, 2002; PEDUNE project, 2000). Cowpea has become one of the most intensively sprayed crops. Fertiliser is not commonly used on cowpea because farmers generally do not think it is needed. One farmer explained why he would not use fertiliser on his cowpea:

> *"Cowpea already is a fertiliser in itself, because if I plant maize after it, the maize yields more than it would do on another plot where cowpea was not previously cultivated."*

The focus of cowpea research in West Africa over the preceeding fifteen to twenty years was mainly to develop cowpea cultivars that are resistant to heat, pests and diseases within a sustainable farming system (Hammond, 2002). When the efforts were evaluated, it appeared that most improved cowpea varieties were not adopted by farmers (IITA, 1997). The reason for this lack of adoption was sought in the method used to promote the research outcomes. FFSs were introduced:

> *"to bridge the gap between technology development on the one hand and dissemination/ adoption on the other hand."* (Hammond, 2002: 3)

Asante *et al.* (no date: 2) explain: [the cowpea FFS project]

> *"is a technology transfer and adoption project in which results of research on sustainable cowpea production and protection technologies are harnessed and made available to farmers."*

They continue:

> "*Before the advent of* [the cowpea FFS project] *however the problem of how to transfer these technologies* [...] *existed.*"

Brief history of the cowpea FFS project

In 1994, the Food and Agriculture Organization (FAO) of the United Nations organised a study trip for African scientists and governmental officials to Asia, to make them aware of the possibilities of farmer participatory training in IPM for sustainable and environmental friendly rice production. Several West African countries expressed their interest to establish such IPM training in their own countries and were supported through FAO's Technical Co-operation programs in collaboration with the West Africa Rice Development Association (WARDA) (Youdeowei, 1996). Ghana requested FAO's assistance to increase its national capacity to implement IPM in intensified production. Project activities started in March 1995 with a project at Dawhenya (ibid). Following the success of this project, the United Nations Development Project supported projects for additional IPM training of farmers from five districts in rice, vegetables and plantain. Youdeowei (2001) reported that, by the end of the year 2000, 106 agricultural extension agents and 77 Non Governmental Organisation (NGO) field staff were trained as FFS facilitators. These trainers trained farmers in ecologically sound production of rice, cassava, vegetables and plantain. NGOs, such as the Ghana Organic Agriculture Network, TechnoServe, CARE International, and ECASARD, as well as the University of Cape Coast, and the University of Ghana, also used the FFS approach. In 1996, the NRI started cowpea FFS as part of a larger regional cowpea project.

The government of Ghana adopted FFSs as a major strategy for implementing the Food Security and Poverty Reduction Programmes. Consequently, the Ministry for Food and Agriculture (MOFA) officially recognised FFSs (Youdeowei, 1999a).

Conducting cowpea FFS

The NRI implemented 36 FFSs in 35 villages[27] in the Northern, Upper East and Upper West Region between 1999 and 2002; half of these FFSs not only focused on cowpea production in the field, but also on storage technologies such as solarisation and double or triple bagging after harvesting. The cowpea FFSs were supported by many donors. Furthermore, district assemblies gave financial support to FFS sessions and participants of the

27 681 farmers participated in the FFS (pers. comm. project assistant) and one FFS was conducted by a farmer trainer.

ToT workshops, but their support varied greatly between districts. The additional training in improved storage methods was funded in collaboration with an international NGO. Since 2002, several donors have however withdrawn because of poor documentation and bookkeeping, and NGOs have not taken over the project, as will be discussed later. As a result, in 2002, FFSs started in four locations, but due to lack of funds, the activities were abandoned halfway.

Understanding farmers' practices

The cowpea FFS project started in 1996, with a general baseline study on cowpea production (PEDUNE project, 2000). The survey revealed that farmers already used many pest control methods. Although mainly synthetic pesticides were used, indigenous control methods, including botanicals, were also applied such as tobacco, *Securidaca longepedunculata* (the bark of a tree, commonly called palga) and *Kaya senegalenis* mixed with wood ash. The outcomes of the survey also demonstrated that yields were lower than the national average (MOFA, 1997). In addition, the use of local varieties was identified as one of the major causes for low crop yields (PEDUNE project, 2000). A gender analysis was not part of the baseline study.

Training of Trainers

The NRI trained MOFA agricultural extension workers to facilitate the FFS. As a first step, some agricultural extension workers acquired experience in FFS and IPM practices during a training trip to FAO FFS projects in Zimbabwe (IITA, 1999). This study trip abroad was followed by a ToT workshop in Tamalé in 1999 in collaboration with the FAO IPM Global Facility and the Ghana National IPM Program (Youdeowei, 1999a). The ToT aimed to equip the future facilitators of FFSs with required skills and to give hands-on training. The training, given by the extension workers who followed FFS in Zimbabwe, FAO consultants and NRI researchers, included education in facilitation and FFS management skills for group building, and competences on 'how to grow a healthy cowpea crop' from a technical point of view. The focus of the TOT however was on the technical elements, more than on the process management. The actual field work comprised crop management trials (that deal with agronomic practices such as method of land preparation, water and soil management, variety and seed selection, plant spacing and weed management, cultural practices and plant protection measures) and participatory action trials (aimed at validating research outputs and dealing with such issues as soil management and nutrients, intercropping, variety, botanical/bio-pesticide and pest assessment trials) (PRONAF project, 2001). The trials could be either completely or partly replicated during the FFS. During the ToT, teams of four to five participants (trainees) conduct an FFS by way of practice. Such a FFS is season-long, which means that the whole sequence of land preparation to harvesting is followed on a weekly basis.

Curriculum development
In 1999, a four-day workshop was organised to develop a curriculum for ToTs and FFSs (Bean/Cowpea CRSP West Africa Project, 1999, Youdeowei, 1999a). The workshop aimed at developing a FFS curriculum for IPM strategies. The focus was on human and environmental safety. The curriculum was developed with the assistance of 12 experts including IPM 'master' trainers (e.g., facilitators who had travelled to Zimbabwe for training), biological researchers, IPM specialists and socio-economists. These experts proposed FFS trials, the spatial design of FFS plots, data sheets and FFS work plans (weekly schedules and tasks) and special topics. Scientists participated on an ad-hoc basis in the development of the curriculum and also in the discussion of special topics in the field.

Conducting FFSs
Ideally, the initiation of FFSs in the communities follows three steps: (1) identification of the problems in cowpea production in the villages selected, (2) preparing the curriculum for the FFS on the basis of problems identified, and (3) the experimentation stage. In practice, however, the same curriculum was used for each FFS.

Methodology

After an exploratory tour in West Africa by the senior author to identify new and innovative research and development projects aimed at improving farmers' livelihoods, the cowpea FFS project emerged as an interesting case. The project had ended allowing an ex-post analysis of the process and impact of FFSs. The role of different stakeholders, such as researchers, extension workers, farmers and policy makers could also be assessed.

The methodology used is a case study analysis, backed-up by a desk study. During the desk study, project documents, archival records of the project and literature about FFSs were reviewed. The desk study included a content analysis of the curriculum. However, the NRI had documented its activities poorly, which made such an analysis complex and also explains the limited number of references to project documents. We therefore had to rely mainly on the memory of the stakeholders involved to understand the series of events that make up the history of these cowpea FFSs. Moreover, some researchers of the NRI were not involved at the start and others were not involved for several years in between. None of the researchers interviewed were involved throughout the lifespan of the project.

As part of the case study, we visited several villages in which cowpea FFSs were conducted. Based on accessibility, proximity, and recommendations by MOFA and the NRI, three villages were selected for further research. No more than three villages were chosen to allow for and in-depth qualitative analysis, building trust and personal relations with the former FFS farmers and also for practical reasons (e.g., limited financial means and transport, proximity). All three villages are located in the same region[28]. In Kilaki and Lumalu, FFSs were organized in 1999, whilst in Menome no FFS was organized. Researching a village with and without a FFS allowed for comparison of farmers' practices in the same agro-ecological zone.

The following methods were used for data collection:

1. *A participatory appraisal was conducted in order to become acquainted with the farmers and their livelihoods, understand the context of the village and gain insight into the impact of FFSs at the village level. Tools included community mapping, problem pyramid analysis, seasonal calendar and history line analysis. In each village, about thirty farmers participated in the FFS and an average of twenty farmers joined in each participatory appraisal exercise. Not all FFS farmers were involved in the present research because some farmers had left the village or were not available.*
2. *Semi-structured interviews were conducted with key informants from all stakeholders involved to gain insight into the process of FFSs (development of the curriculum, training of facilitators, selection of farmers, activities conducted, participants' attendance, etc.). The stakeholders included researchers from the NRI, extension workers who were trained as facilitators, a farmer trainer, farmers who attended the FFS, staff from NGOs working in the field of FFS, the organiser of the curriculum development workshop, and staff of the Ministry of Agriculture.*
3. *Participant observation in a ToT organised in 2002, FFSs organised by NRI on vegetables, and agricultural activities.*
4. *Interviews were conducted to understand stakeholders' appreciation of the project, and changes in knowledge, attitude, practices and skills of farmers as a result of participation in a FFS. A "Strengths, Weaknesses, Opportunities and Threats" (SWOT) analysis was conducted with facilitators/extension workers, researchers and farmers separately. Close to the end of the fieldwork period, a workshop was organised for researchers (2 members participated), extension workers (2), farmers (5) and traders/ processors (4) to generate discussion about the impact of cowpea FFSs and lessons learned. The workshop included a SWOT analysis of the project to allow comparison of the points of view of the different stakeholder groups.*

28 For confidentiality reasons the villages are called Kilaki, Lumalu and Menome.

5. *A survey was carried out in the three selected villages with 60 farmers who participated in cowpea FFSs and 60 farmers who did not. From the farmers who did not participate in FFSs, half were selected from villages where FFSs were carried out (to obtain an idea about diffusion effects within the village), and half from villages where no FFS had been conducted. The farmers were chosen through respectively purposive sampling (e.g., sample from those who had participated in FFSs), and simple random sampling (e.g., in the village where no FFS was conducted). This survey gave insight into the characteristics of farmers and the use of cowpea IPM practices in their production systems*[29].

To cross check some of the information, a second roundtrip was conducted to areas where FFSs were organised in the past. During this trip, four groups of facilitators/extension workers were interviewed (in total 32 agricultural extension agents) from the different districts in which ToTs were organised in order to further explore some of the preliminary findings. Two senior staff members of MOFA were also interviewed. The massive redistribution campaign of MOFA staff at the end of 2003 made it difficult to localise the different facilitators/extension workers and other staff members who were involved in cowpea FFSs. Staff of several NGOs, that have included FFSs in their activities, were also approached. These interviews allowed us some insight in institutional constraints for implementing FFS. In addition, three other former FFS groups were visited and focus group discussions conducted.

Results and analysis

First the principles for developing a curriculum and the technical components of the FFS are revisited, and then the implementation process of IPM practices in farmers' crop management is assessed. Finally, the appreciation of different stakeholders is discussed.

The Farmer Field School curriculum

The cowpea FFS curriculum consisted of practices, including scouting for pest damage and disease attack, preparing and extracting *Neem* for spraying, using the threshold concept to determine when to spray, and differentiating between natural enemy and pest insects. Non-negotiables suggested for curriculum development (see box 1) are the following:

1. *topics chosen by the community*
2. *training building on farmers' existing knowledge*
3. *training based on farmers' needs*
4. *participants involved in curriculum development*

29 This paper mainly discusses the differences in practices as a result of FFS and uses a qualitative approach. For quantitative details and analyses see Odonkor (2004).

Below we use these criteria to assess the curriculum development process in the Cowpea FFS.

Topics chosen by the community

Farmers were not involved in the general curriculum development workshop: extension workers and researchers were expected to translate farmers' problems into topics for the curriculum based on the baseline study. A choice was made ex ante (Giampietro, 2003) to focus on cowpea and particularly pest problems in cowpea production. When the facilitators would start the FFS they would adopt the curriculum developed without negotiating the contents with the farmers. In most FFS, however, the curriculum would be negotiated with the farmers and slightly adapted to their specific needs.

In addition, the curriculum developed during the curriculum development workshop appears to be different from the curriculum that underpinned the implementation of the FFS (field observations; facilitator, personal communication). The reason for this is as follows. When researchers analysed the curriculum developed during the workshop, they felt that not enough focus was placed on improved cowpea varieties and pesticide trials. Even though the researchers were involved in the curriculum development workshop, they had not been able to influence the curriculum development process enough to their liking. Thus they adapted the curriculum to the needs of the NRI after the Workshop, and focused on improved cowpea varieties and pesticide trials. The ultimate goal for the NRI was to stimulate the adoption of the improved cowpea varieties by using a FFS approach, whilst the curriculum development workshop had focused on introducing IPM strategies with a focus on human and environmental safety following the IPM principles for growing a healthy crop. The curriculum development workshop aimed to design FFS for experiential learning to enhance farmers' capacity using an adult education approach, whilst the NRI implemented FFS as a method to transfer technology. The curriculum did not follow the learning cycle (van den Berg, 2001) because there was a predetermined and fixed objective (not shared by all stakeholders) dictating the appropriate curriculum.

Training based on farmers' knowledge

Farmers had an impact on the curriculum through the information they provided during the baseline study. Yet, there was no proof of including farmers' knowledge, such as the use of indigenous pesticide control methods (tobacco, *Securidaca longepedunculata* and *Kaya senegalenis* mixed with wood ash), in the curriculum.

Training based on farmers' needs

In general, MOFA extension workers report to the NRI about problems in the villages they cover. In this sense, the NRI was invited to carry out FFSs programmes based on problems reported by farmers. The NRI also consulted the district assembly for village selection using criteria such as the importance of cowpea production, cotton production (cotton is an indicator for the use of synthetic pesticides not only on cotton but also on other crops), easy accessibility, and personal willingness of farmers to participate in the project.

In all, even though villages with an important cowpea production were chosen, no deliberate effort was undertaken to ground the FFS in farmers' specific needs. In most cases, the extension agent, sometimes accompanied by a researcher and other MOFA staff, visited the village chief to introduce the project. The village chief and the facilitator set a date for a follow-up meeting. The villagers were requested to select thirty participants for the subsequent FFS meetings. In both Kilaki and Lumalu, the village chief selected the thirty participants based upon whether they were engaged in cowpea production, would volunteer, are known as hard working and were expected to be present in the village during the coming season. The extension worker also had an influence on the selection of farmers. Five women were selected in Kilaki and none in Lumalu. In an evaluation of several ToTs and FFSs (Abatania *et al.*, 1999), it was noticed that all participants were male. According to a project staff member, women became more involved later because: *"Donors want to see more women involved!"*

During a subsequent meeting between farmers and the facilitator, conditions for meetings as well as protocols were discussed. The facilitator was supposed to adapt the curriculum based upon the situation in the village. We found, however, that the standard curriculum was duplicated and used. Hence, even though the FFS was conducted in a village that produces cowpea, the detailed needs of farmers were not explored, and the curriculum was not adapted to farmers' specific needs.

Participants involved in curriculum development

Participants in the curriculum development workshop described before included IPM 'master' trainers and researchers of different disciplines. Neither extension workers nor farmers were involved at this stage.

The farmers complained about the lack of follow-up visits by the researchers after the FFSs. As discussed above, curriculum development was not continuous and inclusive, which impacted on all other components of the FFS approach. Scientists directed the contents of the curriculum and therefore had a determinant role.

The initial curriculum had foreseen the following weekly activities of FFSs during the experimentation phase: observations in the field to monitor cowpea, under both farmers and IPM conditions, using AESA as a tool; implementation of decisions based upon the previous week's outcomes of AESA; an icebreaker; and planning of next week's activities. This curriculum was, however, adapted and the AESA exercise was replaced by teaching the economic threshold concept for decision-making about when to use pesticides. The focus therefore shifted from overall plant health and crop performance to evaluating the number of pests on the plants. Youdeowei (1999b:32) suggests that:

> *"The use of economic thresholds for decision making in FFS is inconsistent with the concept of AESA as the decision making tool for crop and pest management."*

Röling (2002: 18) states:

> *"I believe that the great moment in FFS came when the scientific determination of spraying thresholds was left and farmers were left to make their own decisions as long as the process by which they arrived at these decisions was right."*

This last step was not made in the cowpea FFSs of our case study.

As described, technical elements of the FFS were adapted by the lead researchers after the curriculum development workshop. Apart from the threshold concept, the 'safe-use' of pesticides (de-emphasising the ecological approach) was introduced. As a result, the FFSs were not conducted to facilitate experiential learning about IPM practices, but to introduce specific 'IPM practices'.

Sometimes insect zoos were established to monitor the impact of insects on the cowpea plant and to be able to distinguish insect pests from beneficial ones. Data were also collected when Participatory Trials were established. Researchers participated on an ad-hoc basis, typically when a special topic represented their specialisation. Farmers received compensation from NRI for lunch and transport of about half a dollar per FFS session. This compensation, in addition to other costs for running a FFS, limited the possibilities for scaling-up, i.e. for expanding the coverage of larger numbers of farmers and areas, and for incorporating FFS into institutional practices. Farmers in this part of Ghana have been very much used to receiving allowances and this is in general considered a handicap for scaling up, mainly by the NGOs. Some extension workers clearly state that farmers make a trade off between working in their fields and joining extension or FFS-like activities.

Several donors withdrew and stopped funding NRI for implementing FFS. Donors expected national partners to take over the activities. Even though FFS have been adopted as a national extension strategy, which could lead to the expectation that FFS are an integral part of the national agenda, government funds were not often released to implement these activities. Plausible reasons given are lack of funds and other priorities. An additional explanation why it was difficult to scale-up the FFS approach is the limited scope for NGOs to take over the FFS activities because of the allowances paid to farmers they cannot afford to pay.

Participation through incentives (Pretty *et al.*, 1995) proves a constraint to scaling-up. An NGO worker argues:

> *"Farmers will participate in activities without any compensation when they see the benefits, but once a project starts paying compensation all subsequent projects need to do the same if they want farmers to participate. Therefore projects should not even start paying farmers allowances if not all can afford it."*

Another extension worker explained that participants who cannot attend the FFS session sometimes send their relatives, so that they will at least receive their compensation.

Little attention was paid to training farmers as facilitators. Even though some farmers were trained, only one farmer has actually carried out a FFS. That farmer organised a FFS for two subsequent years. The farmer explained that he received support from NRI in the form of seeds, notebooks and materials to prepare *Neem* for spraying purposes. He also explained that some farmers participated in the FFS because this is the only way for them to receive improved cowpea seeds. The farmer facilitator clarified that he would like to organise another FFS, but that his resources are a restriction. He explained that:

> *"All my attention goes to the FFS plot and as a result I yield even less on my own fields than my colleagues do! I am not even taking the yields from the cowpea FFS plot and I cannot afford to use my time and resources again to help others. Unless NRI pays me, I cannot run a FFS again."*

Several farmers who received training as facilitators gave the following reason for not organising a FFS themselves:

> *"I have not graduated from the FFS yet, because I have not received the diploma, and since I have not completed the FFS, I cannot train others."*

Facilitators had promised certificates on the completion of the FFS, but to date no certificates have been distributed. The certificates still are in the office of the director of NRI, awaiting his approval to be distributed. The certificate is considered a diploma farmers need to enhance their credibility as trainers with other farmers.

Implementation process of IPM

Changed practices

Farmers implemented IPM practices introduced by the cowpea FFS project more often than farmers who did not attend a FFS (for more details see Odonkor, 2004).

FFS participants do not differ from non-participants in the same village on criteria such as wealth, religion, age, household size, land ownership, contact with extension agents and farm size. However, 63.3 % of the non-participants and only 33.3 % of the FFS farmers were not educated. This might be an indication that more educated farmers were selected for participation in the FFS.

Non-FFS farmers sprayed intentionally not only against insect pest but also against natural enemies. A farmer explained during an interview:

> *"Spiders make webs that disturb the crops whilst the bees stung the cowpea flowers, just as bees sting human beings, and so cause them to abort, therefore I have to spray and kill all insects including bees and spiders."*

The most obvious difference between farmers who did and who did not attend the FFS is that many farmers who participated in the FFS partly replaced the pyrethroid insecticide *lambda-cyhalothrin* with the botanical *Neem*, whilst farmers who did not attend the FFS continued spraying exclusively *lambda-cyhalothrin*. This information is based on what farmers say, and has not been verified through field observations. There is no proof that non-FFS farmers within the village where a FFS was conducted would adopt *Neem* quicker. Also, farmers having attended the FFS were better aware of safety measures (such as protecting the body) when spraying *lambda-cyhalothrin*.

We noticed during the second roundtrip that farmers who participated in a FFS that did not pay attention to storage (and thus did not treat cowpea in a holistic manner) were less engaged in IPM practices. Wahaga (2003) confirms that storage is an essential element of any cowpea FFS. If the farmers have no means to store the cowpea and have to market it at a time when the prices are not attractive, farmers are less motivated to implement IPM practices.

Application in other crops

Farmers who joined the FFS are applying IPM strategies introduced for cowpea to other crops such as maize, vegetables, groundnut, soybeans and rice. Again, these data are reported by farmers themselves and could not be verified in the field. A farmer explained that after the FFS farmers started applying *Neem* on other crops as well, such as okra, eggplant and cabbage. The reason for this is that farmers appreciate its effect, and especially the low costs involved.

To adapt the IPM practices to other crops, farmers experiment. In some cases they divide a plot in two and apply their conventional practice on one half and the IPM practices on the other half. No experiments with more than two different practices have been reported or observed. Farmers also address questions to the extension agent in order to adapt IPM strategies to other crops than cowpea. Farmers requesting information were predominantly FFS farmers, maybe because of the more intensive interaction between the facilitator and the farmer or the higher education levels of the FFS farmers. Some FFS farmers also went to NRI to ask questions about the adaptation of IPM practices to other crops.

Considering the integration of certain IPM practices in farmers' crop management, we might conclude that FFSs 'worked' to a certain extent. But how did different stakeholders appreciate FFS? How appropriate and acceptable were the cowpea FFSs to the farmers?

Appreciation of stakeholders

Exploring the appreciation of results by farmers

The individual interviews, the SWOT analysis and the discussions about it, show that farmers appreciate the reduction of production costs as a consequence of applying *Neem*. Some farmers state that the use of *Neem* in the field increased their yields (but this probably only applies to the comparison with cowpea production using no pesticide application at all). In addition, cowpea beans taste better because of the absence of synthetic pesticide residues.

Farmers having attended a FFS generally continue applying *Neem* because of improved quality and taste of the beans and the reduction of production costs. However, *Neem* also has some drawbacks according to the farmers. In the first place, *Neem* seeds are not available year round and become less effective after storage. Pounding the seeds is a heavy and difficult process. Also, the collection of the seeds and its preparation into a pesticide require much labour, which is not always available. Most farmers spray *lambda-cyhalothrin* in addition, when pests are abundant. They believe this pyrethroid insecticide is still more effective in 'urgent situations' or when rains have washed away the *Neem*. During our second roundtrip, a group of twenty farmers in a more remote area explained that they would not use the *Neem* on their own fields but only on the collective plots where improved varieties are cultivated. The farmers explain:

> *"It is dangerous to start spraying your local varieties. Ever since we started using fertilizers to produce maize we could not obtain yields anymore without fertilizers. We do not want something similar to happen with our cowpeas."*

We should however clarify that this issue was only mentioned in one place and does not seem an issue for the majority of farmers. *Neem* is the most obvious and popular IPM practice. The appreciation for *Neem* as compared to other IPM practices was apparent when farmers were asked for a symbol to represent 'opportunities' of the project and they chose *Neem* seeds. These findings are confirmed by Nathaniels *et al.* (2003), who found a lack of interest in other practices than *Neem* when they studied the impact of cowpea FFSs in Benin. Abatania *et al.* (1999) also found it to be of foremost benefit to the FFS participants. Even though the FFS approach intends to be holistic, the impact seems to derive from component technologies. Again, this might be a result of the adaptation of the curriculum by the researchers and the focus on technical issues rather than on farmers' needs.

What farmers did not appreciate was that they were not given the cowpea produce after closure of the FFS, nor the tools used such as filters, spraying equipment, microscopes, *Neem* extractor, Wellington boots and bicycles. Farmers also do not have spraying machines and therefore sprinkle the pesticide on the cowpea with leaves or grass. Some farmers explained they would use a broom. In other words, farmers felt they did not derive direct short-term benefits from the project. In addition, the farmers felt researchers made several promises they did not fulfil, such as the certificates mentioned earlier and follow-up visits.

Some farmers found that the FFS took too much of their precious time and some activities were considered inappropriate such as the icebreakers. One farmer commented:

> *"Elderly people had to dance like children at a time we were tired and wanted to go home."*

It seems icebreakers were implemented as an obligatory step in the FFS programme rather than as a means to energize the group when this appeared necessary. It seems that participants had few possibilities to influence the program of the FFS sessions and the rules and conditions were not discussed clearly enough at the start of the project.

Exploring the appreciation of results by researchers

During the different SWOT exercises, researchers claimed that FFSs achieved the aim of introducing IPM to the villages. Cowpea production has become more cost-effective for resource-poor farmers, and farmers differentiate between natural enemies and insect pests and are aware of the advantages of improved cowpea varieties. Farmers themselves did not mention this last advantage. Researchers also noticed a positive effect on dietary practices of farmers, mainly because cowpea production has augmented, and as a result is increasingly used as food, in particular as a weaning meal for babies. Researchers feel that capacities of both NGO staff and extension workers have improved due to the ToT.

Researchers, however, regret that funds became inadequate due to the withdrawal of several donors. Researchers claim that the funds available do not allow for appropriate scaling-up. In addition, researchers notice that well trained facilitators (i.e. those who followed the ToT) either are employed by private NGOs -that pay better- or go back to school. Also, the plots on which FFSs were conducted were often located in a most unfavourable area, for example very far from farmers' fields and therefore the FFSs became very time-consuming for all participants to attend. Researchers also feel that including all stakeholders in planning of activities, budgeting, follow-up and evaluation would have improved the impact and made it easier to achieve the goals of the project. Some researchers specifically mentioned the lack of participation of farmers in the different steps (such as planning, curriculum development and evaluation).

One researcher mentioned not to be very much interested in FFSs because it is difficult for natural scientists to publish on it.

Exploring the appreciation of results by extension agents

Extension workers feel that their relationship with farmers improved and that their ideas about farmers changed; they feel they realise better that farmers can take decisions on their own and solve their problems. Some extension workers felt they gained technical knowledge about cowpea production from farmers. In addition, they notice that the information discussed in FFSs spreads rapidly to other farmers, although this is not confirmed by our study. Due to this change in perception extension agents have about farmers' capacities, trust is fostered between farmers and extension agents. The extension agents also conclude that women are increasingly involved in cowpea production[30] due to the lower costs of pest-management. They argue that women previously were often reluctant to cultivate cowpea due to the high costs of synthetic pesticides. The extension agents also appreciate that the FFSs help to create awareness of their presence in the village.

30 This is however not confirmed by results of our study.

The drawback of the FFS for extension agents is that FFSs are very time-consuming. Extension agents state that FFSs are not part of their programme and hence they have to add it to their already tight schedule. Even though FFSs are recognised as a national extension method, extension workers state that there is no space for it in their program of activities.

A focus group discussion with 20 facilitators/extension workers reported major problems between researchers and themselves. The facilitators/extension workers feel researchers make them do something else each year whilst they themselves do not keep their promises. The extension workers feel the farmers hold them accountable for the problem with the certificates because they are the intermediaries between researchers and farmers. An extension worker explains:

> *"The problems between research and extension agents create problems between extension workers and farmers. Researchers knock the heads of the extension worker and the farmer together!"*

Lessons for interactive approaches

FFSs provide a unique opportunity to not only develop technologies that work, but above all technologies that are acceptable and appropriate to farmers. The cowpea FFSs we studied have, however, ignored this second aspect and used FFSs to push scientist-based ideas about improved varieties and pesticide use. FFS as an approach to IPM is promising, but the application of the FFS approach in this specific case turned out to be an expensive form of transfer of technology. The analysis of the curriculum showed us that the curriculum was adapted by the researchers and used as a blueprint to transfer technologies 'that work' according to scientists to farmers. Since the researchers had 'their own objective' there was no room for grounding the FFS in the specific needs of farmers.

Scientists had pre-determined objectives in mind: choices (Giampietro, 2003), which not only fixed the crop, e.g., cowpea, but also the problem, i.e., pests in cowpea as a standing crop (and ignoring storage). In this case the choices were not negotiated with farmers, which impacted on the usefulness of the approach for the farmers involved.

Researchers chose for FFS as an approach because farmers did not adopt the technologies they developed, in particular the improved varieties they wanted to promote. In choosing the FFS as its favoured strategy for interacting with farmers, the philosophy of the NRI, responsible for cowpea research was that farmers would adopt the research findings if they would see the benefits when they carried out the recommended technologies themselves. FFSs were looked at as instruments to get researchers' message across. Röling (personal communication) made a similar observation in Asia and stressed that the FFS programme was a success in terms of take-up by public agencies exactly because frustrated officials became aware of the ability of FFS to enthuse farmers and to enlist them in their schemes.

It becomes clear that FFSs are considered as an extension method to transfer technology or knowledge and not as a form of experiential learning. The fact that the FFS trainers are mainly extension workers who have been educated within the transfer of technology model might enhance such a conception.

One of the main causes for a low impact of research on farmers' livelihoods in West Africa is that farmers are not involved in decisions concerning research, extension, market, etc. The FFS has proved very efficient in empowering farmers (in Indonesia and beyond), but this potential of FFSs has been missed in our case study example. The project has not improved farmers' countervailing power.

Hence, using FFSs as yet another method to transfer technology leads to the sub optimal utilisation of the real potential of the FFS (i.e. in terms of empowerment, critical thinking, ability to make decisions on the basis of agro-ecosystem analysis, and so forth). This article has revealed the tendency of NRI to use FFSs as a 'transfer of technology' extension method to introduce their technologies to farmers as well as its tendency not to trust farmers' own ability to choose and make decisions and not to consider them co-producers of knowledge. The opportunities provided by the FFS approach to establish collaboration based on mutual respect between scientists, facilitators and farmers was missed.

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CHAPTER 5

Lessons for farmer-oriented research: Experiences from a West-African Soil Fertility Management Project

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Abstract

Donors, scientists and farmers can all benefit from a high impact of research and development projects. However, potential benefits are sometimes not realized. Our objective in this study was to determine why resource-poor farmers in Togo chose (not) to adopt recommended practices promoted through a multi-organizational project on soil fertility management, by examining the processes and outcomes involved.

The paper begins with a brief review of a project that was undertaken in three villages in the Central Region of Togo. The development and research processes that took place during the execution of the project are then critically analysed using an analytical framework that may be useful for improving the impact of future participatory projects.

Our analysis shows that at the macro level, opportunities for innovation were not deliberately explored with participating farmers and other village members and that pre-analytical choices made during the planning phase resulted in practices that resource-poor farmers were, for a variety of reasons, unable or unwilling to adopt. From the outset, donors and scientists focused on soil fertility management, but failed to take into account the wider economic context within which soil fertility management takes place. This was a major obstacle to the subsequent implementation of recommended management strategies. Although the scientists and donor partners measured the success of the Project in terms of crop productivity, farmers' choices were influenced by a complex mix of socio-economic, political and technical factors. The review also illustrated the importance of selecting appropriate categories of farmers for a particular experiment.

In conclusion, for participatory research and development projects to be successful, it is not enough to develop technologies that work. In order to be scaled up and widely implemented, such technologies must meet the needs of resource-poor farmers and be acceptable from a socio-cultural point of view.

Keywords:
Agricultural Research, Farmer livelihoods, Pre-analytical choice, Resource-poor farmers, Technology development, Togo

Introduction

Several authors have expressed skepticism as to whether the attempts made by agricultural research to improve the sustainability of land use for West African farmers have been successful (Bie, 2001; Chambers and Jiggins, 1987; Mutimba, 1997; Pretty, 1995; Stoop, 2002). The 'Green Revolution' in irrigated rice in Asia was mainly based on the introduction of high yielding varieties, which needed inputs such as irrigation, pesticides, and fertilizers in order to be successful. In this particular context it was possible to make the environment fit the genotype (Castillo, 1998). However, in many African contexts, agriculture is too heterogeneous for such an approach. African agriculture has been described as risk-prone, highly diverse, and rain-dependent (Reintjes *et al.*, 1992). In addition to bio-physical constraints, African farmers face low market prices. The availability of cheap agricultural products from regions using green revolution technologies and from industrial countries has driven prices down, worsening the situation for African smallholders.

Under such conditions what can research contribute to agricultural development? The impressive amount of literature written on the impact of research outputs (e.g., Rogers 1995; Scheuermeier *et al.*, 2004) suggests that limited impact can be explained by: (1) farmers' lack of knowledge, (2) and resources, (3) non compatibility of the technologies promoted with farm conditions, (4) and farmers' goals, and (5) the limited political influence of resource-poor farmers on the research process. These problems have been addressed by the Training and Visit approach (Chambers and Jiggins, 1987), Farming Systems Research (Dixon *et al.*, 2001; Collinson, 2000), on-farm research (Werner, 1996; Mutsaers *et al.*, 1997), and participatory technology development methods (Rhoades and Booth, 1982; Pretty *et al.*, 1995; Chambers, 1990, 1994, 1997; Vereijken 1999). A more recent explanation for the limited impact of research on the livelihoods of resource-poor farmers is that researchers alone cannot grasp the complexity and dynamics of local situations (Scheuermeier *et al.*, 2004; Pound *et al.*, 2003). This recognition resulted in the development of different approaches, for example, Participatory Innovation Development (ibid), Enabling Innovation (Douthwaite, 2002), partnership building for advancing Participatory Technology Development (PTD) (Van Veldhuizen *et al.*, 2003), Local Agricultural Research Committees (Ashby *et al.*, 200), Farmer Field Schools (van de Fliert, 1993; CIP-UPWARD, 2003; Pontius *et al.*, 2002) and the Convergence of Sciences (CoS) approach[31] (Hounkonnou et al., 2006). Van de Fliert and Braun (2002) also address this issue and state that it is increasingly accepted that farmers play an important role in research, development and extension.

The present study aims to fine-tune the client-oriented framework for agricultural research, developed within the CoS program, in order to support the development of a perspective on better stakeholder collaboration. Deliberate and careful negotiation and interaction with all stakeholders is considered necessary for agricultural research outcomes to be efficient and fit the needs and opportunities of farmers. Assuming that the context for resource-poor farmers cannot be changed in order to meaningfully apply an innovation, the need to fit innovations produced by science into the existing ecological, social and economical context becomes inescapable.

The research and development Project on Integrated Soil Fertility Management (ISFM)[32] carried out in Togo is used as a case study to analyze the impact of pre-analytical choices on research design and processes. Critical issues emerging from the case are analysed in order to gain insight into the relationships and dynamics underpinning the effectiveness of agricultural research to enhance the livelihoods of resource-poor farmers. These critical issues provide micro case studies within the larger case study, revealing the often transformative effect of the relationship between the context, the activities and outcomes (Tavistock Institute, 1999).

31 Convergence of Sciences (CoS) is a research program (2002-2006) that has been executed by a consortium of the Université de d'Abomey-Calavi, Benin; the University of Ghana; and Wageningen University in the Netherlands. Within the programme eight African PhD researchers worked with a group of farmers who developed technologies in such areas as land use and soil fertility, weed management and plant genetic diversity for food crops, and integrated pest management. They also experimented with ways of improving the framework conditions for technological innovation (van Huis *et al.*, submitted; Röling *et al.*, 2004 and Hounkonnou *et al.*, 2006). The first author is conducting PhD research within the frame of the CoS program to draw comparative lessons from the eight farmer-scientist interactions, so as to throw light on research procedures, methodologies, and processes that were assessed for their effectiveness in improving the livelihoods of resource-poor farmers. The approach CoS used is based on a convergence between scientists and farmer and between biological and social scientists and comprises different phases (see also Nederlof *et al.*, submitted).

32 For purposes of confidentiality the name of the Project has been changed.

We deliberately emphasize farmer perspectives because farmers are the intended beneficiaries. The case reported in this article deliberately aims to draw lessons as to the factors needing consideration in research designed to benefit resource-poor farmers. Hence, this article documents ***research on research.***

Analytical framework and methodology

In this section, we first present the analytical framework, then the methods used in data collection, and finally we introduce the project and the project site.

Analytical framework

The focus of this study is the research *process* rather than the research *outcomes.* An initial analytical framework (Nederlof, 2003) was developed on the basis of a literature review. To validate the initial framework, tools such as brainstorming, validation workshops and discussion sessions, both with individuals and in groups, were organized with CoS and other scientists. In order to develop a research process that benefits resource-poor farmers, we propose five criteria (see also Röling *et al.*, 2004[33]):

1. *Research takes into account existing opportunities or potential for innovation at a macro level. This implies a thorough understanding of the context and stakeholders concerned before the start of the project.*
2. *Research is grounded in the opportunities and needs of intended beneficiaries.' This means anchoring research activities in local conditions, and in stakeholder demands and needs, specifically those of resource-poor farmers.*
3. *Research designs systems that work under the conditions facing farmers. Hence, the (agricultural) innovation or technology developed is possible and effective given the actual farming system and field conditions.*
4. *Research designs systems that are acceptable and appropriate for resource-poor farmers. This implies that the innovation or technology not only yields the desired results but also fits the culture, preferences, traditions, personal circumstances and priorities of resource-poor farmers.*
5. *Research develops innovations that can be scaled up. Thus, the technologies or innovations developed potentially have an impact beyond that of the farmers initially involved and the duration of the project.*

33 Röling used insights from Van Schoubroeck (1999) and Tekelenburg (2001).

In discussing these criteria, certain proxies (because the criteria are not in and of themselves 'measurable') are considered. These proxies are cross-cutting, meaning that they are relevant to more than one of the criteria:

1. *Participation of stakeholders in "platforms" to engage in collaborative learning. Pretty (1994, 1995, et al. 1995) developed a ladder distinguishing different types of participation. He argues that for sustainable development nothing less than interactive participation34 is required. Participation is a tool to facilitate learning that increases the countervailing power of farmers over the research process (the democratization of science, c.f. Funtowicz and Ravetz, 1993). Johnson et al. (2003) assessed the impact of participatory methods on research usefulness, and found that participation resulted in greater economic impact and more relevant innovations, mainly when implemented at an early stage in the research process. In the late seventies, Morss (1976) made very similar observations.*
2. *Socio-cultural factors related to communities, the production system, and technical aspects.*
3. *The interface between technical / biological and social issues.*
4. *Factors related to the wider context affecting farmer livelihoods (e.g. marketing possibilities).*
5. *The assumption that farmers have veto power (Röling et al., 2004) and therefore that research must be negotiated with farmers. The design of research processes is at the interface between science and the veto power of farmers. Hence the choices made (e.g., hypotheses, topic, type of benefit to be achieved) can hamper the impact of the research if not negotiated with farmers. Giampietro (2003: 30) calls these choices 'pre-analytical' and defines them as the 'choice of relevant goals, variables, and explanatory dynamics for the selection of an explanatory model'. To explain the concept, he uses Mandelbrot's (1967, in Giampietro, 2003) example: if you want to know the length of Britain's coastline, you better agree on the scale of the map that is to be used, because the scale will strongly affect the result.*

In our case study, stakeholders, including farmers, were asked to evaluate the Project and related issues. This allowed the framework to be fine-tuned as the study progressed. The proxies thus emerged during the case study and should therefore be considered an outcome of the present study.

34 People participate in a joint analysis that might lead to action planning and the formation or strengthening of local institutions, it tends to involve interdisciplinary methodologies that seek multiple perspectives and make use of systematic and structured learning processes.

Methodology

We opted for a qualitative research approach due to the exploratory, conceptual and constructive character of the study (see Denzin & Lincoln, 1994; Guba & Lincoln, 1989). Two principles guided the collection of data for the case study: (1) include rich detail in recording events, interviews and observations; and (2) use triangulation of methods in data collection to allow cross-validation of information (Texas State Auditor's Office, 1995). We used the following approach.

First of all, a desk study was conducted to review soil fertility management literature. We also analysed the Project's archival records (documents including informal reports, notes, correspondence, etc.). Most documents concerning the Project were confidential and therefore no explicit references are cited in this article. Data on the context (both in terms of the area and the villages in which the Project carried out its activities and in terms of participants and stakeholders) were gathered through the desk study.

Second, between October 2003 and April 2004 several visits were made to the research sites (i.e. the three villages in which the Project was conducted). The first author was not involved in Project implementation; however, the second author facilitated the research and development processes. The combination allowed both an outsider and an insider perspective of the project to emerge. The second author has both an agronomic and an extension studies background, while the first author is a social scientist (including anthropology), allowing for a diversity of perspectives. During the field visits, the authors made participant observations during 1) field days organized by national research and extension services, 2) participatory evaluations of the strategies proposed by farmers and organized by the international institute, 3) meetings of the regional platform, and 4) data collection by research partners in farmers' fields.

Third, the authors conducted semi-structured interviews with the stakeholders. All interviews were conducted by the authors. Approximately thirty farmers were interviewed individually in their fields. Three farmer groups were visited for discussions. Three representatives of the international institute involved in the Project were interviewed and joint field visits were also organized. In addition, we interviewed directors of the research, extension and agricultural policy analysis institutes that were involved in this project, as well as the professionals delegated to the project by each institute. During such interviews, the strengths, weaknesses, opportunities and constraints of Project activities were analysed. In the end, all individuals involved in the Project were interviewed.

Description of the Project

In this chapter we explain the contents of the Project, introduce the stakeholders, and describe the project location.

Description of Project content

The Integrated Soil Fertility Management Project, carried out between 1999 and 2003 in Central Togo, aimed to ameliorate the livelihoods of resource-poor farmers through soil fertility improvement. This focus was based on the assumption that soil mining leads to nutrient depletion, decreased soil fertility, declining production and hence poverty (Stoorvogel and Smaling, 1990). The Project focused on the adoption and maintenance of integrated soil fertility management practices. The main results expected from the Project were the identification and adaptation of strategies for different circumstances by using systematic learning with the stakeholders; making fertility management strategies, methods and data available to various stakeholders; strengthening the capacities of researchers and extension agents so as to facilitate farmer innovation; and strengthening partnerships through Project coordination and management.

The Project facilitated negotiation among scientists, farmers, and national partners. It not only systematically tested technologies but also engaged in development activities mainly through providing advisory services to farmers. Extension was mainly supported by demonstration plots and research was based on Participatory Technology Development (PTD). PTD is a process of purposeful and creative interaction between farmers and outside facilitators to develop technological options. It involves various processes such as gaining understanding of eco-specific and cultural contexts; defining priority problems and local experimentation; involving farmers in generating locally adapted technologies; and evaluating whether farmers internalized these technologies (for details see Jiggins and de Zeeuw, 1992; Van Veldhuizen *et al.*, 2003).

Introducing the stakeholders

The Project involved various stakeholders ranging from an international institute, decentralized departments of national extension, research and policy analysis agencies and resource-poor farmers.

The extension service's main activity in the Project was to demonstrate innovations for diffusion to farmers through such tools as demonstration plots, farmer field days and

Individual Farm Management Advice[35]. The major innovations introduced were the use of the leguminous cover crop *Mucuna pririens* var *utilis* and manure pits. Both innovations were demonstrated in farmers' fields. In addition, cereal banks[36] were set up.

The main research activity of the Project was to set up experiments with farmers based on endogenous practices. Experiments undertaken included (see Table 1 below): (1) determination of optimal chemical fertilizers doses for a leguminous cover crop-cereal system; (2) determination of optimal chemical fertilizer doses in a rotational leguminous cover crop-cereal system; and (3) improvement of fertilizer efficiency in a combined leguminous cover crop-cereal system[37].

35 Individual Farm Management Advice is better known under its French name: Conseil de Gestion. It is a holistic extension tool for an individual household and aims to improve production levels and soil fertility strategies. It consists of a series of visits by the extension agent to the farmer aimed at giving her or him farm-specific advice. Results are encouraging but the scope for scaling up is limited due to the high costs involved and the low farmer extension worker ratio.

36 A cereal bank (Kpaikpai, 2003) is a group of people that agrees to jointly store their products when prices are low and the product is abundant. When the product becomes scarce and prices increase, the product is sold. This not only allows selling the product at a higher price, but since prices are in general higher just before the next season starts, it also makes cash available at a time it is needed for the start of the next season (e.g., for purchasing agricultural inputs, hiring labour). Well-known drawbacks of cereal banks are that the moisture content of the grains, and as a result the weight, decreases, individuals might want to sell the bags at other times, costs for a care taker, and other additional costs that are not foreseen by farmers and result in accusation of stealing etc. (Röling, pers. comm.)

37 These experiments are based on contracts that were made between farmers and scientists during the diagnosis.

Table 1: Research activities in the Soil Fertility Project

Village	Activity year 1 and 2
Ababa	Determination of optimum rates of mineral fertilizer applications on maize in the *cowpea-maize relay cropping system.* Determination of optimum rates of mineral fertilizer applications on maize in the *soybean-maize rotation system.*
Figigi	Improving the endogenous system of *Egusi melon-maize relay cropping system* through mineral fertilizer applications on maize. Improving the endogenous system of *Egusi melon-Cowpea and maize rotation system* through mineral fertilizer applications on maize.
Cedede	Determination of optimum rates of mineral fertilizer applications on maize crops in the *soybean-maize rotation system.* Determination of optimum rates of mineral fertilizer applications on sorghum crops in the *cowpea-sorghum mix-cropping system.*

Agricultural policy analysts were responsible for general coordination of the Project in the Central Region and monitoring and evaluating the research processes; this included field visits for discussion with farmers, and the facilitation of meetings between the different organizations. The international institute supported these activities through training and monitoring. For a summary of the different Project activities of the stakeholders, see Figure 1.

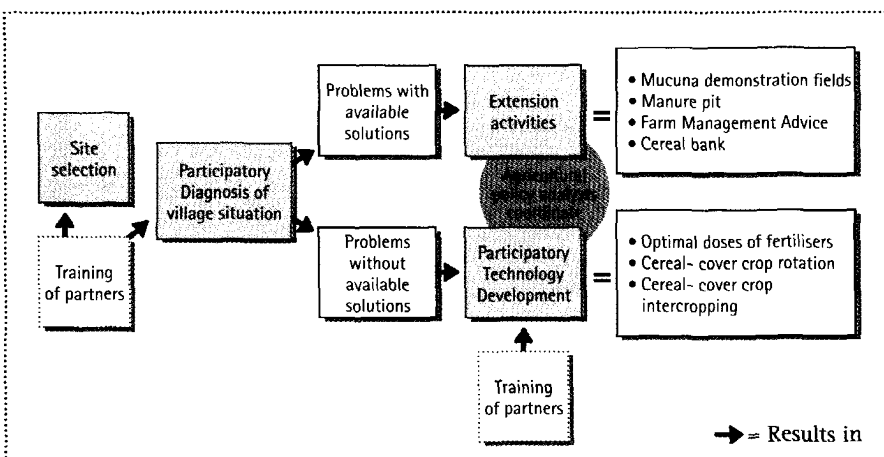

Figure 1: Sequence of activities in the Soil Fertility Project.

Project location

The Project took place in the Central Region, one of five regions in Togo. This region is characterized by annual rainfall of between 1000 and 1200 mm. There is one rainy season from April to October and harvesting takes place in November and December. Soil types include tropical ferruginous and ferralitic soils. Causes of soil degradation are sheet erosion, reduction of organic matter in the topsoil and loss of plant nutrients (Brabant *et al.*, 1996).

The Project had three research sites: Affem-Kabyé, Sessaro and Goubi. The three villages were selected during a workshop with the main national partners. Criteria provided by the Project for site selection were: accessibility (practical); level of soil degradation, crops cultivated, level of intensification including fertilizers use (situational); and receptivity for innovations, socio-economic and cultural context, and access to innovations (social)[38].

The main cropping systems in each of the three villages are maize-based, cotton-based and yam-based respectively. Legumes such as cowpea, soybean, groundnut and *Cajanus cajan* are used in rotation and relay cropping is practiced. Although cattle are used for animal traction, the main livestock component in the agricultural system is small ruminants (sheep and goat) and poultry. The dominant ethnic group in both Affem-Kabyé and Sessaro is made up of Kabyé migrants from the northern part of the country. Affelees are the dominant ethnic group in the third village, Goubi. Mineral fertilizers are used, but less so in Sessaro because the village tends to have even fewer resources than the others. In Goubi farmers tend not to be very concerned about soil fertility due to the abundance of fallow land. Whereas in both Affem-Kabyé and Sessaro compound farming is very important, in Goubi the farms and housing areas are spatially separate.

Research findings

In this article, we seek to assess each of the criteria discussed in the analytical framework, using some of the proxies discussed above. Discussion of each criterion starts with a short presentation of the key concepts used for analysis and ends with concluding remarks.

Does the Project take existing macro-level opportunities or potential for innovation into account?

Research planning ideally is negotiated among the different stakeholders concerned, including the ultimate beneficiaries, i.e., the farmers (e.g., Johnson *et al.*, 2003). Did this

38 Given the institutional complexity of the Project, the selection could have been influenced by any of a number of factors, including personal reasons of officials.

happen in practice, or were project contents established at a central level? Initial choices could have been influenced by factors such as donor requirements, the personal preferences of scientists and the personal convictions of people involved. The quality and acceptability of these pre-analytical choices (Giampietro, 2003), depends on the process through which the choices are made.

Pre-analytical choices

During the first negotiation phase between the donor and the international institute realizing the Project, several choices were made that did not involve farmers. A first choice was that soil fertility management was to be the topic, rather than rural credit, which had initially been proposed by the international institute. International literature (Steiner *et al.*, 1988, Pieri, 1989, Stroosnijder, 1992, Swift, 1996, Mazzucato and Niemeyer, 2000, Stroosnijder and Van Rheenen, 2001) suggests that soil fertility management is indeed a major issue in this region. A second choice, based on the ideas of specialized scientists within the international institute, was that agriculture needed to be intensified in order to improve production; it is assumed that an increase in production would benefit farmers and reduce poverty. A third choice was the focus on technology development rather than rural development (including infrastructure, market development etc.). Such choices can have major implications in terms of operationalizing project objectives, as will be demonstrated below.

Problems, solutions and criteria for activities that were listed during the initial donor meeting had to be grounded in the demands of country partners in order to fit the specific context. The international institute therefore organized a country meeting with potential stakeholders, including the governmental research and extension organizations, the agricultural policy analysis organization and a Non-Governmental Organization (NGO) working on credit, to present the outcomes of the donor workshop and discuss the way forward. The choice to base the Project in the Central Region of Togo was based on the need to improve the rural credit scheme, which was the initial topic proposed. This choice was not reconsidered by the partners even after the focus of the Project changed. Thus, the choice of region was made before the final topic was known. It soon became clear that the NGO initially involved was not interested in the new direction that the Project had taken, which in its opinion could not be linked to credit, and decided to withdraw. Other partners, however, decided to join because of the likely importance of the subject.

Concluding remarks on taking into account macro-level opportunities

The research topic, soil fertility, and general contents (problems, solutions and criteria for activities) were negotiated at a higher level of decision-making and respected donor requirements. The outcomes of the meetings with donors were discussed with local partners in the pre-selected province; however, the partners could either join or withdraw but not negotiate the activities, objectives and conditions, which had already been established during the donor meeting. Indeed one intended partner, who was not dependent on the expected Project resources, withdrew. The other partners chose to join the Project because they considered soil fertility to be a problem. No deliberate attempt was made by the international institute to understand the reasons behind partners participation. It was assumed that the choices made at the 'higher-level' meetings would benefit the farmers although they themselves were not directly consulted. A dilemma for numerous (participatory) projects is how to involve farmers in the project planning and negotiation phase. What alternative methods for involving farers in project development might be possible, especially in West Africa where farmers have limited political clout? In our study, it is difficult to evaluate whether soil fertility was indeed the most relevant issue to be tackled from the perspective of farmers. Despite the many justifications found in international literature that support the choice for soil fertility improvement, it is important to verify such assumptions with farmers and to even change the topic, if necessary. Röling *et al.* (2004) argue that it is at least as important to provide farmers with the opportunity to influence the topic as it is to ground research in international literature. However, the fact that farmers were not involved does not mean that the topic was not of interest to them. The point is that soil fertility management was chosen as the focus of the Project based on donor requirements and the ideas of expert scientists, without taking into account farmer perspectives.

Are the Project activities grounded in the needs and expectations of resource-poor farmers?

The first question is: who were the farmers? Then the process of negotiating experiments and trials is revisited.

Farmers involved

During a community meeting following a participatory diagnosis, farmers volunteered to participate in the Project's activities. The project worked intensively with 60 households equally distributed across the three villages. Twenty-six of these households have relatively large farms (more than five hectares). From field observations, discussions with the farmers and data available within the Project about farmer characteristics, it became clear that participation was predominantly from the relatively resource-rich, better-informed and well-educated male farmers in the community. A critically-minded staff member of the international institute expressed this concern when stating:

> *'It is worrying that only a small group of farmers is involved, and that those farmers are the ones who have relatively big fields, and much labor available.'*

Johnson *et al.* (2003) argue that farmers choosing to participate in projects are unlikely to be the poorest in the community or from a marginalized group. In addition, chances are that these farmers have had previous experience with experimentation. The agricultural extension agent also suggested that some 'lead' farmers would be included. Röling (1988) states that extension workers tend to interact with the top 10-20% of the farmers, and that, in the absence of explicit efforts to involve the poorer farmers, it is safe to assume that the relatively better-off are involved.

Women were not involved in the Project, despite the fact that farming at the intervention sites, is largely women's work. Women sow and harvest, while men plough the land, and together they weed and maintain the plots. The neglect of gender aspects was confirmed in Project documentation, which reported that already at the diagnosis phase 'a major shortcoming was the weak participation of women'. The partners claimed this was due to the cultural context in which they were operating. The organization of the village is based on a hierarchical patriarchal system and women do not generally participate in important meetings, including community and Project meetings, when men are involved. As a result only men participated in the meetings and subsequent Project activities. Even when women were present at a meeting they were expected to remain quiet in the company of men. Some women cooked food for the men attending the meetings, but this can hardly be considered participation.

The following critical incident concerning a soybean density trial demonstrates the importance of including women in experiments. A woman farmer explained that she obtained higher yield using her traditional production method than with the introduced practices. According to the researcher who was working in the area this could be explained by the way in which the plot was sown:

> *"When the extension agent went to the local pub to have a tchouk, he met one of the farmers participating in the trial on soybean density. Under the joy of the tchouk, the extension agent explained to the farmer exactly how to sow the plot. The farmer was to divide the plot into four quarters, sow using two different densities; two plots were to be lines and the other two at random, and apply varying fertilizer applications. Since his wife was responsible for sowing the fields, when the farmer arrived home, he immediately explained to his wife what the extension agent had just told him. A few days later the woman went to the field and sowed the plot following her husband's explanations. The woman did not fully understand the second-hand explanation and as a result there were few differences in sowing practices between the four plots. The plot did simply not respect the extension agent's protocol for research."*

As women are responsible for sowing, the Project could not succeed without their involvement.

Negotiating experiments

Experiments can be based on "contracts" made between farmers and scientists. In Affem-Kabyé and Sessaro a participatory diagnosis resulted in a contract to develop collective solutions for soil fertility improvement based on local practices. In Goubi it led to an agreement to raise awareness about the importance of maintaining soil fertility.

To ground the Project in the needs, demands, and conditions of farmers, the national partners undertook a diagnostic study of soil fertility management[39] issues with farmers, using participatory methods. A team of agronomists and socio-economists carried out a diagnosis by visiting the villages. The study allowed for an understanding of community processes, as well as traditional practices and previous experiences in soil fertility management. It also allowed the partners to be properly introduced to the local authorities, and obtain general information about the village.

The diagnosis identified concrete problems related to soil fertility decline experienced by farmers. In both Affem-Kabyé and Sessaro, the farmers believed low production to be largely the result of soil depletion. However, from the process used it cannot be concluded that soil fertility depletion is indeed a major preoccupation for farmers. Farmers may well have deduced that assistance might be forthcoming if they focused on the topic evident on the logo of the land rovers. However, a clear indication that the farmers considered soil fertility to be a problem is their development and practice of soil fertility improvement measurements.

In Goubi, soils are still relatively fertile and almost no chemical fertilizer is used except in cotton cultivation. The availability of unexploited land in forest areas surrounding the village allows farmers to practice shifting cultivation. The diagnosis in this village was a first step towards raising awareness about the threat of soil depletion in the future. The farmers indicated interest in further exploration of the situation.

Depending on the type of problems that farmers identified in relation to soil fertility, different strategies were followed. For problems that had already existing solutions, and that were considered suitable for extension at the national level, the extension service was

39 Tools used were community mapping, transect walk, semi-structured interviewing, flow diagram, wealth ranking and Venn diagramming.

the main national stakeholder. A total of 114 farmers were trained in *Mucuna* fallowing, 30 in composting techniques, and 91 demonstration plots were prepared across the three village sites. Following information sessions on co-operative issues, eight farmer groups in Affem-Kabyé and two groups in Goubi started cereal banks. In addition several field days were organized to inform non-participating farmers of these activities. The international institute also reported that 14 farmers in the three village-sites received individual farm management advice. Success was measured in terms of the number of farmers reached.

Box 1: **Researcher-led experiment**

When the agricultural extension agent was harvesting the soybean density plot together with the farmer on whose land the trial had been installed, the farmer became tired and left. He told the agricultural extension agent he would take a rest and return but he never came back and left the agricultural extension agent alone with the work. This was the farmer's way of saying he did not agree with the manner in which they had to harvest the field for the scientists. The agricultural extension agent followed the evaluation form handed out by the research service, which included an indicator on the number of grains. To estimate the number of grains, the soybean had to be threshed, what usually is not done. The farmer did not understand the logic of doing this additional work and decided to withdraw. It later appeared that the agricultural extension agent indeed misunderstood the requirement. The case shows that farmers not only negotiate through discussion but also through action. In this example indicators for evaluating the trial were not negotiated, and as a result the experiment turned out the agricultural extension agent's responsibility rather than the farmer's.

For more innovative solutions, endogenous practices identified during the diagnosis formed a basis for improving practices through PTD. Researchers suggested a number of possible experiments based on the results of the participatory diagnosis to improve upon existing practices. The farmers in turn prioritized the options and researchers retained about three experiments, taking into account both feasibility and farmers' choice.

According to the international institute, the research conducted is farmer-led, on-farm research. However, ownership was not always well negotiated and in some circumstances the experiments turned out to be researcher-led as illustrated in box 1.

Another example stressing the importance of ownership of the research relates to the soybean density trial in Affem-Kabyé. When discussing the trial, researchers repeatedly stressed that the experiments belonged to the farmers who work for themselves and not for the researchers. Some time later a farmer involved in the soybean trial explained that he decided to dig up the soybean plants that had not received fertilizers because they were not doing well. As a result the difference in yields was not large. One of the researchers became mad at the farmer and asked him why he had not done what he was told to do. The researcher then explained to the farmer that the results were no longer comparable due to his intervention and had become useless. A bit later the researcher calmed down and requested that the farmer would not act in such a way again. The farmer replied:

> *"Yes sir, I will not deceive you again, and I will not spoil your experiment again."*

During the first two cropping seasons no control plots were set up, because farmers did not see the benefits. As such it was impossible for biological scientists to make sound statements. During the third cropping season, the trial design was therefore re-negotiated and control plots were included in order to make the study scientifically sound according to the criteria of biological science. The researchers managed to convince the farmers that they needed a control plot in order to be able to draw conclusions. In one of the villages it was very difficult to convince the farmers of this need. Farmers in Affem-Kabyé argued that they always use fertilizer in maize production and therefore did not think it sensible to compare a fertilized plot to a plot where no fertilizer had been applied (the control).

In another case, a farmer in Goubi applied fertilizer on a control plot because he was not willing to risk production level losses. At times, it appears illogical to farmers to compare an introduced practice with what they already do. The experience of Björnsen Gurung (2003) confirmed that the scientific approach of comparing two systems that differ by only one factor is indeed illogical for farmers. As farmers seek benefits rather than proof, it is unacceptable for them to leave parts of their plots untreated when there is another production method that is more likely to succeed (ibid).

During the first two cropping seasons, different trials were conducted in the three villages depending on farmer preferences. However, biological scientists require replication to be able to say something about the effect of an introduced practice (because of possible side effects) and it was therefore necessary to conduct the same trials in all three villages during subsequent cropping seasons. This design allowed biological scientists to gather sufficient data. As such, farmers' needs were given less priority during the third year and the conditions for the experiments proved to have been insufficiently negotiated. The farmer in Goubi who hosted the soybean varietal trial explained that other farmers rarely came to see the experiment. He explained this by repeating what he had already indicated during the diagnosis phase, that local farmers do not have a soil fertility problem. Hence farmers participated by providing their fields and labor to carry out experiments for scientists on a topic in which they had already indicated disinterest during the diagnostic phase.

Concluding remarks on grounding activities in farmers' needs

A diagnostic phase ideally provides ample opportunity for negotiating between farmers and researchers in order to assure that the interests of both are met. The international institute made several pre-analytical decisions about Project design that farmers and partners could not influence but were compelled to accept. First of all, it was assumed that 1) solutions for some problems were already available and could be brought to farmers via extension services and 2) some solutions are not yet available and demand exploration with farmers. Secondly, productivity was chosen as the criterion for success. This favored a focus on large farmers with whom uptake and impact generally happen more quickly. What the participatory diagnosis did not address is the context within which the project strategies were embedded (market outlet, availability of fertilizers and seed, different soil fertility management approaches by land owners and migrants as discussed by Saïdou *et al.* (2004) and Adjei-Nsiah *et al.* (2004)).

After the donor withdrew and the ISFM Project was integrated into another project of the same international institute, the role of biological scientists became increasingly more important and as a result the requirement to produce scientifically sound data prevailed. Scientific rigor made it necessary to compare two systems that differ with one factor and are replicable. Scientific requirements - the ability to replicate and need for controls in order to draw scientifically sound conclusions - were not sufficiently negotiated with farmers.

So, why did the farmers then agree to the proposed experiments? One group of farmers answered a question with respect to their readiness to participate in the research trials as follows:

> *"If you give us the inputs we want to participate, but if we have to buy them ourselves that changes everything!"*

Has the Project designed systems that work under farmers' conditions and that are acceptable/ appropriate for resource-poor farmers?

The Project delivered extension messages about problems for which solutions were considered available and engaged in further trials with farmers on other issues. Have these two types of efforts benefited resource-poor farmers? Did the context allow the innovations introduced to benefit resource-poor farmers? Below, the perspective of each of the stakeholders is discussed.

Evaluation of Project results by the international institute

Based on an evaluation[40] of research activities, the international institute concluded that the systems developed work in the farming system under study. The most successful participatory trial was the relay-cowpea-maize cropping system. The yields in this system were comparable to the optimal yields obtained in a simulation model. Average maize grain yields doubled in two years. The farmer who had the highest level of production - seven tons per hectare - was based in Affem-Kabyè. The trial in which he was involved allowed farmers to harvest two different crops on the same plot in one cropping season. The average maize grain yields in the *Egusi* melon-maize relay cropping system also increased but not impressively. The use of fertilizers in the endogenous *Egusi* melon-Cowpea and maize rotation system improved maize grain yields. The effect of both fertilizers and the preceding cowpea crop improved yields. Also, the yields were higher where the residues of soybean were incorporated into the soils in a soybean-maize rotation system, although the difference was not large. Another result was that an improved sorghum variety was not suitable for the cowpea-sorghum mixed cropping system. The main criterion for the international institute was yield and hence the results of the PTD activities seemed promising. However, how many farmers can achieve these results? And if they can, is there a viable strategy to market the surplus production?

Evaluation of Project results by national partners

Both researchers and extension workers expressed their satisfaction with the Project's results. They most appreciated the project's participatory approach. Researchers and extension workers felt that farmer knowledge was taken seriously and that farmers were involved in the experiments. However, researchers and extension workers seemed reluctant to openly criticize the Project. A first explanation for their reticence might be that the Project provided researchers and extension workers with supplementary revenue (in the form of a daily subsistence allowance for field trips and remuneration in the case of extension workers) and as a result they had an interest in sustaining it. A second explanation might be that researchers did not think criticism would make a difference. Researchers themselves have become skeptical about the impact a project can have on sustainable development. Box 2 demonstrates that some researchers have lost confidence in what can be achieved through a research project.

From the interviews it appeared that agricultural policy analysts appreciated the Project results very much because they felt the results contributed to the development of options for increased production. Increased yields also improved their credibility vis-à-vis the farmers.

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40 Plots of similar size and different applications were harvested and yields put in a bag. The bags were compared to determine best practices.

Due to increased production, (urban) consumers could purchase produce at a lower price. In an informal discussion, the director of the agricultural policy institute courageously admitted that farmers then receive lower prices. So farmers do not share the same interests as (urban) consumers and alternatively marketing options for farmers must be found. A major drawback of the Project, according to the director, was the limited funds available and as a result, the limited possibilities for scaling up to other districts. Understandably, researchers and extension workers supported this view.

Evaluation of Project results by farmers

The soil fertility improvement technologies tested were often positively evaluated by farmers and Project partners alike. These evaluations concerned the technical performance of the innovation under specific conditions, however, the technical performance of an innovation is just one reason for implementation. The critical incidents reported below, demonstrate the mix of criteria used by farmers (see Table 2). We first discuss the results of the extension work (i.e., problems for which solutions were considered to be 'on the shelf'), and then of the experiments.

Box 2: **The young researcher**

During a field trip to discuss some preliminary findings of the project activities of the preceding season with the farmers, a young researcher was discouraged by the low uptake of some of the strategies proposed. The discouragement was very evident from the expression on his face. When the other researchers returned to the car, we overheard them commenting on the young researcher. One of them said: "poor guy, he still believes farmers will one day adopt what researchers introduce", and another added: "once he has more experience he will learn that making a change for farmers is no more than a dream". The researchers continued commenting on the young researcher stressing that no research project they have ever seen has made an impact.

Table 2: Farmers' indicators for assessing an innovation

Indictors in the technical domain	Indicators in the socio-economical domain
Yields	Land tenure arrangements
Organic biomass content	Integration in farm (Multi-purpose crop)
Climatic conditions	Farming calendar
	Marketing possibilities
	Cost efficiency (investment needed)
	Short-term benefit
	Labor needs

Results from extension messages

An important technology introduced by extension was the use of *Mucuna puriens* as a green manure cover crop to increase soil organic mater content. It was observed during the farm visits that few farmers use *Mucuna*. In general the farmers at the research site acknowledged the effect of *Mucuna* to be remarkable due to its capacity to increase biomass and hence organic matter content. Yields of maize increase considerably if *Mucuna* has preceded it. It was reported by scientists involved in the Project that one year of Mucuna production can be equated with five years of fallow. However, the use of *Mucuna* for improved soil fertility has major drawbacks according to the farmers interviewed such as: slow decomposition of stalks in the field; inflammability of a dry *Mucuna* crop; the likelihood of tenants losing their plots because owners withdraw them after a *Mucuna* season; high labor requirements; and, the fact that *Mucuna* cannot be used for other purposes such as seed consumption, animal fodder or building material. Also, this part of the country has only one rainy season so that farmers will 'lose the season' if they cultivate *Mucuna*. One farmer explained:

> *"If the rains come you have to choose your crops, and since we cannot eat Mucuna, the choice is quickly made..."*

Other technical problems include that *Mucuna* is difficult to plough under with animal traction; it provides favorable conditions for scorpions and snakes; it germinates abundantly the year after sowing due to bursting of pods; and, it needs to be protected against bush fires. The farmers explained their low uptake of *Mucuna* through reasons other than technical performance and yield increase. Deffo *et al.* (2002 and 2004), Tarawali *et al.* (1999) and Manyong *et al.* (1996) reported similar problems with *Mucuna*. Several farmers explained that they had already tried *Mucuna* before the Project came to their village and that they would abandon it once the Project ends. The *Mucuna* story shows that available technology that is 'on the shelf' according to scientists, is not necessarily acceptable to farmers. Figure 2 gives an overview of farmer motivations influencing *Mucuna* uptake.

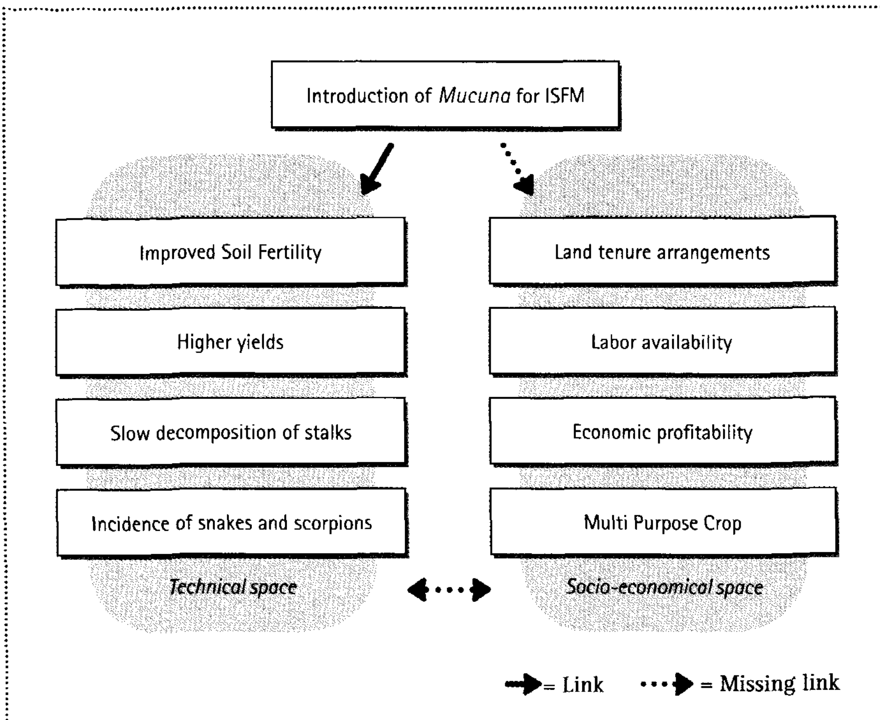

Figure 2: Linking Technical and Socio-economical space: the case of Mucuna

Extension activities also triggered individual discovery learning as is demonstrated in this account of a critical incident. Some of the farmers, who did not want to lose an entire cropping season to *Mucuna*, tried intercropping *Mucuna* with maize. Others preferred intercropping sorghum with *Mucuna* because of the cultural and social value attributed to sorghum. Despite the Project's warnings that *Mucuna* would overrun the sorghum, one farmer in Sessaro decided to try this practice in his field. In fact, he had already concluded that his sorghum production yield was lost and therefore could afford using that plot for experimentation. During a field day a group of farmers visited his plot and concluded that *Mucuna* had indeed largely overrun sorghum. Although scientists concluded the practice was not successful, one farmer commented:

"Even though I agree that Mucuna overruns sorghum, the farmer improved his soil fertility and in addition he has at least some sorghum which is already better than Mucuna alone!"

The example clearly demonstrates that stakeholders use different indicators to measure an innovation's success.

The Project aimed to improve soil fertility through integrated soil fertility management strategies such as organic manure, chemical fertilizers and cover crops. As a result of these practices, the production of maize, for example, did indeed increase as reported earlier. During our field visits, the major preoccupation of farmers was the slump in maize prices. Even though farmers had a surplus of maize, it was not possible for them to actually sell it. One farmer said:

"We followed your advice to improve our soil fertility, and now here we are with our surplus, what are we supposed to do with our maize? You should not advise people to produce more if you have no market for the produce."

Consequently, the Project introduced cereal banks. Cereal banks allow storing the storage of produce immediately after harvest when the price is low until the price goes up again. However, this year, farmers complained that the price remained low year-round[41].

After analyzing the statistical data (FAOSTAT, 2004), it was indeed confirmed that the price decreased by 25% compared to the previous year and 20% compared to the five-year average. The fact that production had only increased slightly (i.e. 1% compared to last year and 12% compared to the five year average) is an indication that more maize is available on the market. The reason is likely due to the fact that maize production in neighboring countries increased by 21% compared with the previous year (ibid). Also, cheap maize and other food product imports year-round have undermined the seasonal rhythm on which the cereal bank is based.

Fertilizers are generally expensive (the equivalent of 15.5 USD[42] e.g., 7500 FCFA for a bag of 50 kilos, pers. comm. Dangbégnon) if available at all, and as a result production costs are high. In such a situation, fertilizer application may increase yields, but higher yields may not improve resource-poor farmers' livelihoods, if not accompanied by institutional or socio-economic development. One farmer stated:

41 The problem of maize price slump seems a regional one. Farmers had the same complaints in the Central region of Benin (observation in S. Aliou's field on 17.10.03) and in Burkina Faso.

42 From http://www.oanda.com/convert/fxhistory

"We do not need your help anymore to increase our production levels, because we attained that objective and know how to do that, but we want you to change your objective and help us with better markets for our yields."

The introduction of cereal banks did not prove to be sufficient to overcome the marketing problem. Figure 3 gives a schematic overview of how different factors are interlinked. One of the staff members of the international institute argued that indeed:

"The Project should not take increased productivity out of its context, but look at the entire context prerequisite for rural development that is networking, knowledge and information, market development and credit."

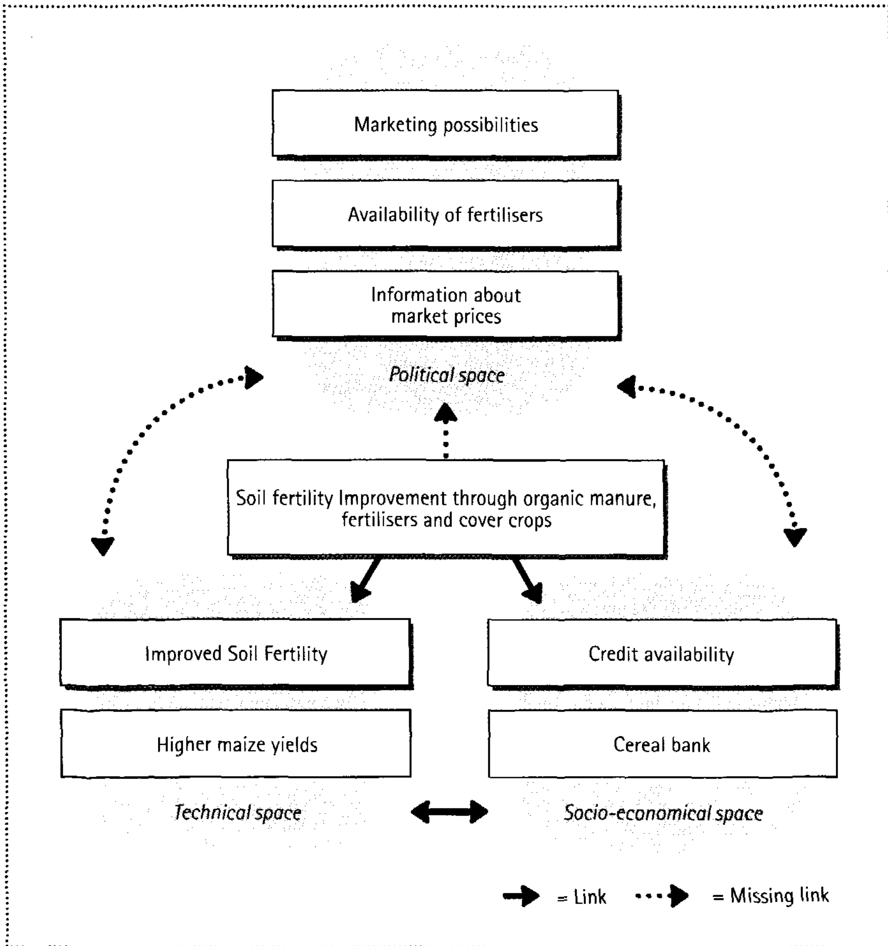

Figure 3: Linking socio-economical, technical and political space

Giller *et al.* (2003) discuss the different impacts policy can have (see figure 4). In a discussion with a group of farmers and the agricultural extension agent in Sessaro about individual farm management advice, the following concern was raised:

> *"The farmer you see over there does not want other farmers to visit his field during the farmer field day this year. During last year's farmer field day he received much attention when visiting farmers were impressed by the high yields he was able to produce due to the soil fertility improvement strategies he had practiced. Shortly after the farmer field day he fell ill. The farmer claims that one of the visiting farmers has bewitched him out of jealousy about the high yield he obtained. He dropped all the practices the individual farm management advisor had recommended even though he was convinced of their benefit. The farmer spent all his money on medicines and has 'no force' left to work in the field. The farmer argues that it does not make sense to become rich if it means losing your health or maybe even your life."*

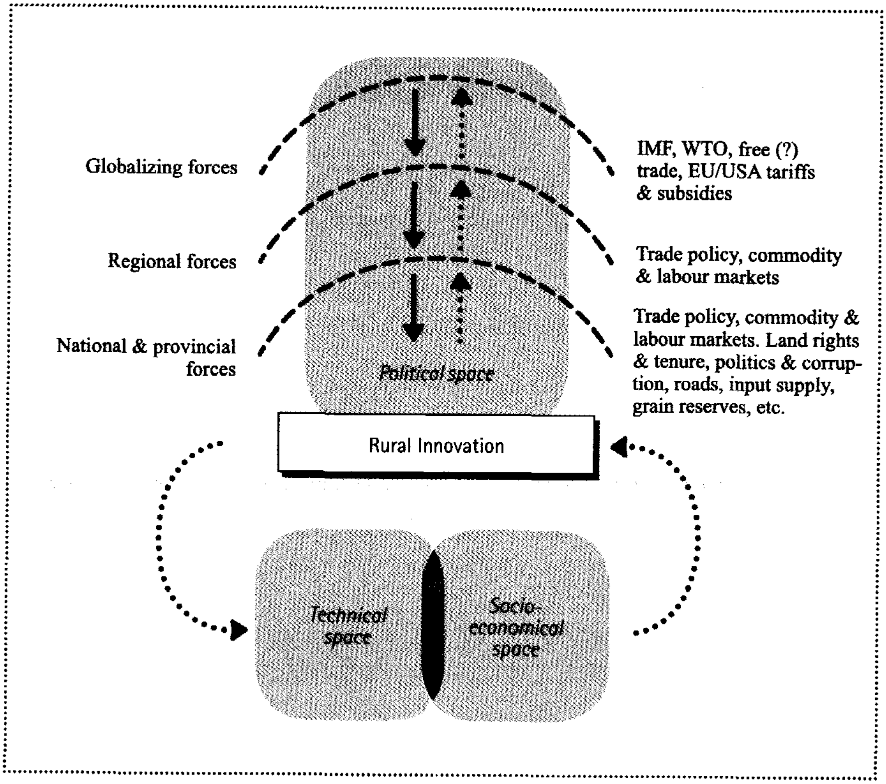

Figure 4: Political space further explored (Adapted from Giller *et al*, 2003)

This example demonstrates that the often-made assumption that individuals can progress if they make an effort can be wrong in another social context. Leveling mechanisms that aim to even out the distribution of wealth (Nanda, 1990) are very strong and imply that people do not want to publicly display their wealth (Breusers *et al.*, 1998). Farmers believe witchcraft to be real in its consequences and capable of having an impact on their well-being. Leveling mechanisms can take many forms (Nanda, 1990) and in this case resulted in a lack of follow-up on Project recommendations.

Results of research experiments

Experiments on soybean to increase organic matter content were conducted. Soybean is a non-traditional crop and is not often consumed[43] in the rural communities involved in the study. An NGO contracted farmers to produce soybean and guaranteed a ready-market for the produce. The presence of a market outlet motivated farmers to engage in soybean production. Moreover, they preferred soybean to *Mucuna*. The advantage of soybean is that is a multi-purpose crop (food, fodder, organic matter). In addition, soybean had a market potential, as discussed above. Farmers were however primarily interested in soybean grains and consider the soil fertility improvement effect as an advantageous side effect, whereas soil scientists mainly evaluated soybean on the basis of the biomass available for soil fertility improvement. A farmer commenting on the soybean varietal trial observed:

> *"The soybean variety soil scientists prefer is indeed high and green but that is not what we look for. The variety they choose has only two grains per pod and the pods are only near the top, not covering the whole stalk."*

One farmer who participated in a soybean trial had left the residues in the field for distribution over the land the next day. In the evening his brother passed by and noticed the heap of soybean residues. He decided to clean the plot for his brother and burned it. This illustrates that it is not only the owner who makes decisions about the plot, but also other family members.

Farmers prefer cowpea, on which experiments were also conducted. Cowpea can be planted very early and rotated with maize during the same cropping season. Cowpea does not only have a positive effect on maize yields but more importantly can be used to bridge the hunger gap (it can be harvested very early) and can also be sold on the local market. In addition, cowpea is a multi-purpose crop that fits more easily into the farming calendar

43 Lately however a Non Governmental Organisation demonstrated how soybean cheese and mustard can be produced and soybean is gaining popularity for home consumption.

due to its early harvest. The problem with cowpea is its susceptibility to pests. However, for the year we are reporting on, very few farmers planted a cowpea-maize rotation trial because the rains came too late leading the farmers to decide that it was impossible to sow cowpea before maize. In this example, climatic conditions led farmers to decide that the trial would not be interesting. This illustrates, once again that technical solutions are not fixed blueprints but depend on a complex mix of factors.

A farmer participating in the relay cropping Egusi-Maize on-farm trial in Goubi did not respect the fertilizer rate application stipulated in the protocol. He bought additional fertilizer which he applied both on the treatment plot and on the control plots. Maize yields on the different treatments plots motivated the researchers to investigate the situation. The farmer explained that he wanted high yields on his plots and applied what he had learned in the previous year from the Project's activities.

Concluding remarks on systems that work and are acceptable

Scientists in the Project focused on designing systems that work and less on 'appropriate technologies'. The experiences with Mucuna probably provided the clearest example. The high yields obtained with Mucuna convinced scientists that farmers would accept the crop, overlooking the fact that farmers use additional criteria to determine acceptability. Therefore it is necessary to consider farmers' conditions for acceptability.

Another example was the early indication of farmers from Goubi during the diagnostic phase that soil fertility degradation was not a problem. Even when soil fertility is an issue, farmers may not use fertilizers if they are either unavailable or considered to be too expensive. The case study demonstrates that farmers have 'veto power' (Röling *et al.*, 2004) and will not use technologies that do not benefit them. Scientists determined what is (not) a solution for the farmers, but did not take into account that farmers may have other priorities and that increased production is not necessarily amongst them depending on other context conditions.

Whereas the soil scientists involved in the project used yields and bio-mass content as the main indicators of success, farmers used a mix of criteria both in technical and socio-economic domains in which yield is only one factor, albeit an important one.

The farmers selected for participation in the Project were predominantly the relatively resource-rich farmers in the community due to increased chances that such farmers would adopt the strategies introduced. These farmers complained that their main problem was the commercialization of their produce. It could well be that the Project targeted the wrong farmers[44].

44 Dr Thom Kuyper (pers. comm.)

The farmers we spoke to complained about the lack of market and low prices. This also demonstrates that new problems arise as a result of solving old ones. Therefore a continual assessment of the context is required if the aim is to design useful research for resource-poor farmers.

Has the research developed innovations that can be scaled up?

Scaling up usually means moving beyond the local or pilot level to include more beneficiaries and to involve other agencies in terms of management and funding with a view to making a larger impact and one beyond the project duration while hopefully continuing to foster participation of intended beneficiaries and other stakeholders involved (Uvin and Millar, 1994; Douthwaite *et al.*, 2003). What lessons can be learned about what the Project has done to scale up its pilot activities?

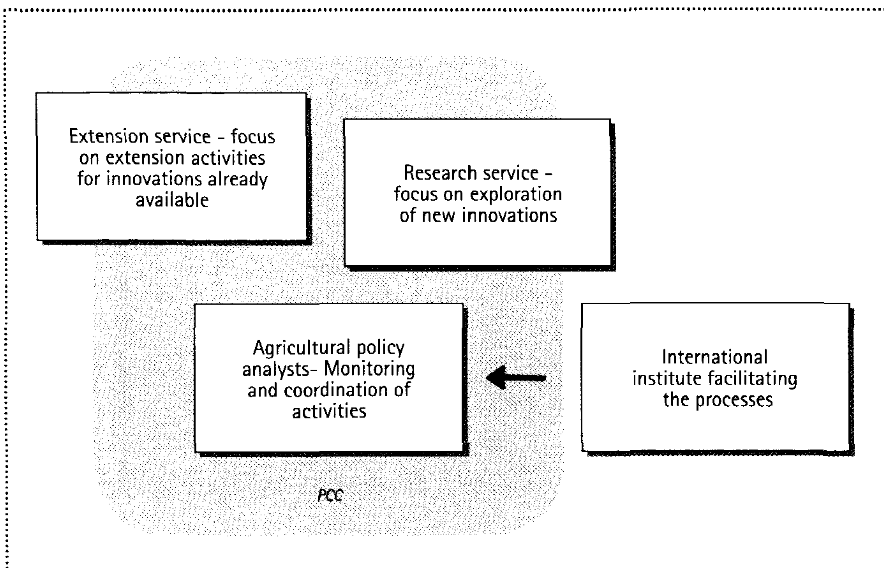

Figure 5: An inter-institutional platform in the Soil Fertility Project

Intra-institutional collaboration

A platform was constituted to involve different institutional actors and thereby to penetrate the political scene for scaling up purposes. A Project Coordination Committee (PCC) was established to facilitate the implementation of the Project, guide the research process, and make it possible to continue activities in the Project area. It was hoped that this PCC would eventually carry out the activities by itself. A platform perspective was used (Dangbégnon *et al.*, 2001) to set up such a collaborative development and research framework. The PCC consisted of the national partners in research, extension, and agricultural policy analysis and the international organization and as such helped to inform and involve policy makers at the level of the Central Region of Togo. Farmers and their organizations were not represented. The PCC was designed as an inter-institutional platform[45] and functioned as a forum for negotiation between the national stakeholders (see figure 5).

A difficulty encountered by the Project was the high turnover of the PCC members; in the end none of the original members were still involved. The new members had to be briefed about the history and norms and rules of the platform. Another problem was the lack of communication between the people on the platform and the members of the organization they represented. Collective commitment to continuation of the platform and the project activities was not self-evident.

Spontaneous scaling up

"Informal" or "spontaneous" horizontal scaling up through diffusion has taken place. Such a process is also referred to in the literature as 'scaling-out' (see Douthwaite *et al.*, 2003). Several farmers from surrounding villages or non-participating farmers from the same village reported for example having received seed from fellow farmers or having heard from a neighbor. These farmers also experimented before adopting the practices demonstrated.

In addition, during the farmer field day, it was observed that farmers from other villages who had not received invitations also participated. There had been no incentive such as transport reimbursement. A critical staff member of the international institute wondered whether they should continue to invest in trials, given that farmers are very capable of experimenting independently.

Other dimensions of scaling up

Scaling up has, however, another dimension. The case study clearly shows that technical aspects (e.g., soil fertility, productivity per hectare) are but one bottleneck in development. Once they are overcome, then other issues such as marketing become the limiting factor. Spontaneous diffusion of technologies, the great multiplier of research impact (e.g., Rogers, 1995), requires a favorable context. This includes availability of and access to credit facilities, security of land use, timely access to high quality fertilizers, appropriate and functioning extension services, and most importantly the availability of and access to marketing channels and acceptable prices.

45 The concept of 'platform' originally emerged in the context of natural resource management (Röling and Jiggins, 1998). Nowadays it has, however, a much wider applicability.

Concluding remarks on scaling up

For scaling up the notion of replicability is essential. One cannot expect the Project process to be replicated if the conditions created by the Project were artificial. Several factors impact on scaling up. In the first place, partnerships that allow for interaction and ownership among different stakeholders need to be built up so as to foster internalization of the Project objectives. Secondly, the political context must be favorable.

Finally, scaling out requires that diversity in the farmer population be taken into account. Resource poor farmers do not necessarily have the same options as large farmers. When women do the farm work, it is important that they be included.

Concluding remarks: Emerging lessons about effective research for resource-poor farmers

The case study analysis based on five criteria for farmer-oriented research allows us to draw out a number of lessons regarding agricultural research that is effective in ameliorating the livelihoods of resource-poor farmers. During the fieldwork for this study, farmers mentioned on several occasions that the research conducted does not always address their needs and that research results do not routinely benefit them. What explains the (lack of) impact of the ISFM Project on farmers' livelihoods? By way of conclusion we assert the following:

1. *Pre-analytical choices determined the scope and possible impact of the research and extension activities on farmers' livelihoods. Pre-analytical choices were made by donors and the international research institute and were insufficiently negotiated with resource-poor farmers. The Project was not used to develop effective farmer clout over the Project's activities. Consequently, ownership of the activities remained with the scientists and planners, with the result that the technologies introduced and tested did not adhere to the criteria outlined at the beginning of the article and will not autonomously diffuse amongst farmers.*

2. *Solutions that are technically sound are not necessarily acceptable to resource-poor farmers. The assumption that science has technologies 'on the shelf' that can solve farmer problems is particularly dangerous. In this case study, scientists decided that existing technologies (for example the use of Mucuna to increase organic matter content) provide the best technical means to solve soil fertility problems. This decision is based on a test of "what works" and not "what is acceptable". However, scientists decided 'what works' on the basis of narrow criteria e.g., Mucuna's contribution to organic matter content and yield. Farmers used a more complex set of criteria such as labor costs, production of edible grains, etc.*

3. *Solving a problem generates other problems. When some farmers improved the soil fertility and increased production, they could not market their produce. This means that agricultural research must continually engage in diagnosis of what the relevant problems are. Also, the context changes (e.g., prices for agricultural products rise and fall) affecting the relevance of project activities.*

4. *Appropriate categories of farmers need to be addressed. Farmers are not homogenous in terms of needs and perceptions e.g., soil fertility is an urgent problem for resource-poor farmers who do not have the labor or the financial means available to improve soil fertility and hence have limited 'space for innovation.' However, the Project seemed to focus on farmers whit the means and labor to deal with soil fertility problems, but who instead face market challenges (for their surplus production). In addition, other procedures to involve women need to be explored.*

5. *The farmers revealed that a complex mix of socio-economic, political and technical factors influenced their choices for the uptake or rejection of certain agricultural techniques and technologies. Therefore, farmer uptake can only be understood if the socio-cultural context is taken into account. Cultural values are too often overlooked, yet, have a major impact on how resource-poor farmers perceive agriculture and the usefulness of the technologies proposed.*

Many questions remain unanswered when it comes to the critical issue of making agricultural research relevant to achieving the Millennium Development Goals. But our case study demonstrates that it is not enough to develop systems that work. Farm innovation needs to be embedded in macro-level opportunities, grounded in resource-poor farmers' needs, be acceptable to them and allow for scaling up.

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INTERMEZZO

Fine-tuning the analytical framework of a pathway for agricultural science impact

In Chapter 1 and 2 of the dissertation we discussed the need to review the current research pathway. The main question this dissertation addresses is the following:

> *"What criteria does formal agricultural research have to meet so as to ensure that the research benefits resource-poor West African farmers?"*

In order to answer this question we proposed an initial framework (in Chapter 2) which includes criteria for a research design that increases the likelihood that the research helps improve livelihoods of resource-poor farmers. The framework also includes a number of issues (themes and topics) from a literature review that are expected to impact on a useful pathway of science.

In Chapters 4 (Nederlof and Odonkor, in press) and 5 (Nederlof and Dangbégnon, in press), we studied two cases of completed research project activities in West Africa to gain insight into perceptions of researchers, farmers and other stakeholders, into potential innovative research methods and into research processes. Both case studies underlined the importance of properly identifying research questions, thereby integrating natural and social science disciplines, and farmers' knowledge, and developing a research design that integrates different types of research: fundamental, on-station, on-farm, contextual analysis and co-research amongst different stakeholders. In addition, the analysis of the two case studies helped to identify, analyse and operationalise issues relevant for useful research. The cowpea Farmer Field School (FFS) case (Chapter 4) mainly helped us to understand how research intended to emphasize learning by farmers quickly eroded into a transfer of technology project and hence how the potential of such a useful approach can remain unrealised. The soil fertility case (Chapter 5) mainly helped us to gain insight into criteria used in priority setting of research projects and how that influences the research pathway.

Cross-cutting issues as lessons drawn from the analysis of the two external case studies are:

1. *Making explicit the pre-analytical choices made.*
2. *Engage in a multi-stakeholder learning process.*
3. *Integrating social and biological sciences.*
4. *Democratisation of science. The importance of involving every stakeholder including farmers in all steps of the research process, as well as of identifying needs and designing a research protocol.*
5. *Contextual factors influence resource-poor farmers' practices. This involves linking social, political and economic space. For example in the case of soil fertility improvement, the context (in terms of opportunities for marketing produce) proved limiting and surpluses could not be marketed. It showed that a different approach is needed for cash crops than for subsistence crops. Cash (commercial) crops often have relatively fixed marketing value, while the market for subsistence crops is highly uncertain and variable.*

The present intermezzo proposes a fine-tuned analytical framework to look at science pathways. This will be used to analyse the research practices of the CoS Programme in chapters 6 and 7 and further develop the framework. As a first step, insight from the case studies helped us to re-analyse the previous doctoral work of van Schoubroek (1999) and Tekelenburg (2001).

Re-analysing previous doctoral work to explore the contours of an alternative pathway of science

In developing alternative views on an engagement between agricultural researchers and resource-poor west African farmers that leads to positive outcomes for the latter in terms of livelihoods, food security and sustainable land use, we rely on the work of two innovative Wageningen researchers. The first, van Schoubroeck (1999), an entomologist who became a volunteer in Bhutan, took a year to identify what he could most usefully do as the, at that time only, entomologist in the country. When he arrived, he was told to work on stem borers in maize because everyone grows maize, and stem borers are a major problem. But he soon found out that farmers are not too worried about stem borers. They grow enough maize to satisfy domestic demand and they convert the surplus which they cannot sell into an alcoholic drink. It is only after a deliberate search that van Schoubroeck discovered that farmers exported a large amount of citrus fruits (mandarins) to India and that they suffered heavy losses from fruit drop. His work on this issue identified the culprit, the Chinese fruit fly, *Bactrocera minax* (Diptera : Tephritidae : Dacinae), the maggots of which caused the drop and rotting of fruit. Van Schoubroeck set to work on the taxonomy, life cycle, pheromones, and other aspects of the fruit fly. In fact, he could have obtained his doctorate on this work alone: it was objective, experimental, and replicable, fitted into the scientific discourse, and was published in refereed journals. But van Schoubroeck was not satisfied. He realised that his scientific results meant nothing to the lives of resource-poor Bhutanese farmers. He therefore took another year to work with two villages to 'translate' his scientific results into practices that farmers could follow to control the fruit fly without recourse to spraying or other unsustainable and unaffordable measures. A special problem was that the practices proposed to control the fruit fly would only be effective if farmers at the level of the village would participate. His work was effective... in the two villages. Van Schoubroeck failed, by his own admission, to 'scale up' his results through extension to other villages that were in the same predicament. Apparently, extension could not replicate the intensive learning that occurred during the year that van Schoubroeck and the villagers developed effective control practices that heeded the Buddhist percept of protecting all sentient beings.

Van Schoubroeck's work has been hugely influential for the CoS programme (Röling *et al.*, 2004). It suggested that, in order to effectively contribute to farmers' livelihoods, agricultural research must pay attention to (1) diagnosis to identify a problem that merits investment, (2) sound scientific applied research to establish 'what works', (3) 'translation' of the results of scientific research into appropriate farmer practices that are effective at the local level in dealing with the problem and that are acceptable to farmers, and (4) scaling up the results to a wider population of farmers facing the same problem.

Van Schoubroeck was an engaged researcher. He was not satisfied with objectivity, validity and reliability, the conventional criteria for 'good' research. His work implied a commitment to research as a public good that contributes to the livelihoods of resource-poor farmers. This implied the use of additional criteria, such as *relevance* in terms of addressing a problem that matters to farmers, *effectiveness* in addressing the farmers' problem, *appropriateness* in terms of the feasibility of local implementation, *acceptability* in terms of the goodness of fit with local culture, and finally *scalability*, the extent to which the practices that emerge from the process can be replicated by other farmers within the prevailing framework conditions.

In terms of specifying the nature of the process of engagement between scientists and farmers, van Schoubroeck's work suggests a phase of *problem identification and diagnosis*, a phase of *applied science*, a phase of *field experimentation with farmers* so as to establish effective and acceptable practices at the local level, and a phase of *scaling up*. With respect to this last phase, van Schoubroeck's work confirms the insight also gained in the work with IPM Farmer Field Schools (van den Berg, 2003). Both showed that innovations, which go beyond simple technical recipes (e.g., applying fertiliser) and that are knowledge and organisation-intensive (Smits, 2000), such as timely, village-wide concerted action based on a thorough understanding of the life cycle of a fruit fly, cannot easily be disseminated by conventional extension agents and require farmer *education*.

The second researcher is Tekelenburg (2001), who worked for eight years as team leader of a land rehabilitation programme that tried to reduce poverty and the degradation of dry farmlands in the high Andes of Bolivia. The project tried to give new impetus to the degraded farmland by capturing the added value of multi-functional use of Cactus Pear (*Opuntia ficus indica*) for erosion control, cattle food, fruit production and the growing of cochineal (*Dactylopius coccus*), a scale insect that is used for making an expensive natural food dye. As a result of his experience, Tekelenburg developed what he called a 'cross-epistemological management toolkit for the interactive design of farm innovation'. It is grounded in a project that achieved considerable success in improving the livelihoods of very poor Andean farmers and reflects learning of the team and the farmers over an eight-year period.

Figure 1 shows his 'management toolkit' for designing interactive learning (Tekelenburg, 2001: 127). After problem identification, two pathways must be worked out: problem analysis and goal setting. Then four types of action (research and design) can be chosen at four levels of complexity. The results of these actions must be integrated into solutions for the problem.

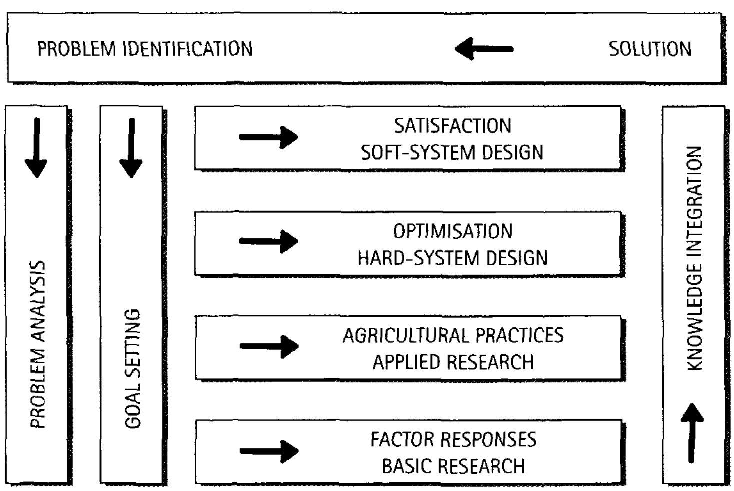

Figure 1: Management toolkit for designing interactive learning processes (Tekelenburg, 2001: 127)

The four horizontal boxes, basic research (bottom), applied research, hard system design and soft system design (top), represent increasing levels of social complexity, respectively (Tekelenburg, 2001: 31):

- Identification of mechanisms (explanation and understanding).
- Solving the problem (effectiveness).
- Optimising the situation (optimisation).
- Improving the situation (satisfaction).

Each level incorporates the previous ones and adds new challenges. There is no necessary sequence to the various steps, except perhaps problem identification, problem analysis and goal setting. The process is one of iteration through the various elements. There is not one pathway, but many different ones, depending on the nature of the situation, the problem, etc. Basic research does not, for example, always precede hard system design. While struggling to design effective systems, new questions might pop up that require basic and/or applied research.

Tekelenburg adds considerably to the points raised by van Schoubroeck. He distinguishes between research and design. In other words, designing solutions is as important as (co-) producing knowledge. He also distinguishes between hard and soft system design, with the former aiming at achieving given goals, while the latter takes goals to be part of the process. His work further clearly raises issues with respect to criteria. On the one hand, Tekelenburg (2001: 31) speaks of 'expected outcomes', i.e. understanding and explanation, effectiveness, optimisation and satisfaction (Figure 1). On the other hand, his work suggests that very different criteria are to be applied to the four research- and design approaches that are to lead to these outcomes:

- *Understanding and explanation* require objectivity, validity and reliability.
- *Effective solutions* require developing the best means that work for achieving some human end.
- *Optimisation* requires adaptation to prevailing and often changing physical, ecological and economic framework conditions. The effective solution must be practicable in the circumstances.
- *Satisfaction* requires an effective process among the stakeholders that leads to understanding, agreement, organisation, cultural and institutional incorporation, and concerted action. Key is whether resource-poor farmers have been empowered to influence the process.

One issue that is not explicitly addressed by either van Schoubroeck or Tekelenburg is the identification of the *opportunity* for research to make a contribution. Identifying an opportunity is the essence of *entrepreneurial innovation*, in that it is the challenge for the entrepreneur to link a perceived opportunity to existing means or resources under his/her control. Once that link has been perceived, knowledge, credit, work, technology, etc. can be applied to realise it. It is this quintessential entrepreneurial action that usually initiates innovation, not scientific research per se (Kline & Rosenberg, 1986).

Van Schoubroeck basically played an entrepreneurial role when he identified the damage caused by the Chinese fruit fly as the key bottleneck in the full exploitation of the virtually bottomless Indian market for Bhutanese mandarins. Tekelenburg did the same by identifying the potential for revalorising degraded land through the multi-functional use of the Cactus Pear. We feel that *identifying such opportunities* is a key feature of developing a theatre of innovation. It is only partly captured by what Tekelenburg calls problem identification, problem analysis, and goal setting. Opportunity seems to be a key ingredient in an effective pathway of science.

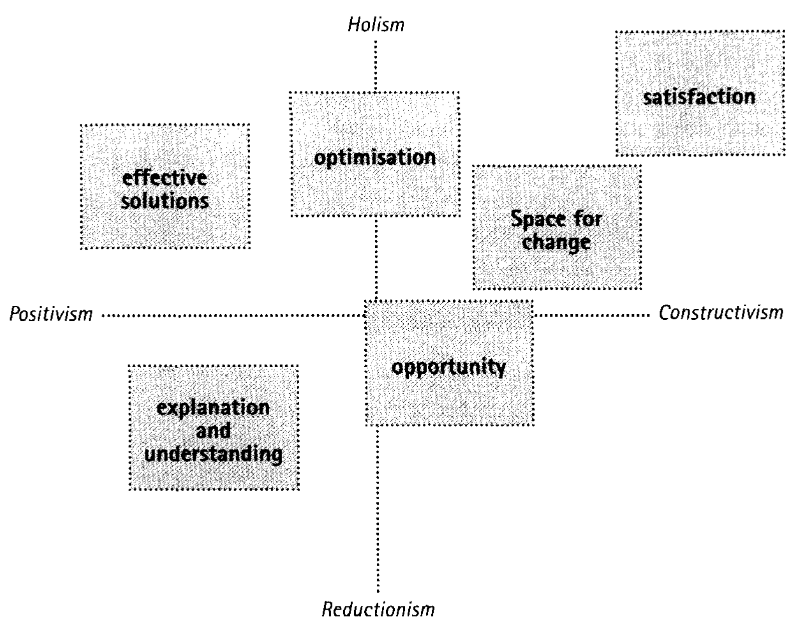

Figure 2: The outcomes within Miller's Epistemological Quadrants (Miller, 1983 and 1985)

It is our experience that agricultural researchers often consider science-based technologies to be the source of opportunity. Therefore they start with the promise of gene technology, information technology, precision farming, etc., and consider the development of such technologies as the first step in the entire innovation process or pathway. Taking technology as the first supply-driven step in the innovation process to our opinion violates the fundamentally dyadic nature of the pathway of science and ignores the many other drivers of opportunity, such as changes in institutions, regulations, market opportunities, values, and climate (Jiggins, pers. com. March 2006).

We position the expected outcomes of following the pathway of science in Miller's typology of scientific approaches (Miller, 1983 and 1985; Bawden, 2000; Röling, 2000) (Figure 2). This figure frames the nature of the assumptions and the levels of complexity that are at stake when we speak of the pathway of science.

Lessons from the two case studies

The analysis of the two external case studies helped us understand that the process of grounding research in beneficiaries' needs is continuous. Conditions can change at any time and hence research needs to be adapted to these changing conditions. Further, developing technologies might include on-station or laboratory (fundamental or mono-disciplinary) research. It is not always possible or necessary to carry out research on the farm or with farmers. The level of farmers involvement depends on the technology developed. For example, the area-wide biological control programme in Africa, where exotic beneficials were introduced to control invasive species did not need to involve farmers. However, agronomic practices to control pests need to be carried out by farmers, so their involvement is crucial (Van Huis and Meerman, 1997).

Pre-analytical choices are made for a research location/ village, the selection of the (innovative) farmers who will participate in the research, the negotiation of the research protocol, etc. Röling (personal communication) emphasizes the need to maintain a diagnostic perspective throughout the whole research to reassure a flexible research process that allows adaptation. Our soil fertility case study confirms this:

> *"A continual assessment of the context is required if the aim is to design useful research for resource-poor farmers."* (Nederlof and Dangbégnon, in press: *21*)

For example, once a problem is solved (e.g., soil fertility) another problem might emerge (e.g., market opportunities).

It is during the diagnostic exploration that the foundations for experiments are laid and that the choices for the types of research that are needed are made. In the cowpea case study, for example, the farmers were not involved in the FFS curriculum development, stronger: the curriculum was adapted by the researchers to meet their goals. Hence, the researchers had made assumptions (e.g., farmers want increased productivity) about farmers' goals and the reasons for their action. In addition, even if researchers would be capable of identifying farmers' bottlenecks, farmers need to be involved to enhance ownership and (future) participation. Hence, the experiments were not grounded in the farmers' needs, which inevitably led to problems later. It is necessary to collaboratively define a set of criteria for research evaluation from the beginning (e.g., the soil fertility case demonstrated that, if no clear indicators are established at the start, pre-conceived solutions and not involving farmers in decision-making about research design can lead to problems).

Additional topics identified during the analysis of the two external case studies were: (1) setting the research agenda; (2) differences in rationality between farmers and scientists, for example, different conceptions about control plots and replication during participatory technology development; and (3) exploring the area of research (as a problem and opportunity) with all stakeholders including (different groups of) farmers.

In many projects, farmers are not involved in identification of opportunities and setting up research at the village level (e.g., as we saw in the cowpea FFS case, farmers were not involved in FFS curriculum development. In the soil fertility case, farmers were also not involved in choosing the topic and in negotiating the details of the protocol including indicators for evaluation and the need for replication). It might be necessary to carry out laboratory (explaining and understanding (causal) relationships) or on-farm research (effective solutions) in addition to collaborative research (Participatory Technology Development). It might be necessary, for example, to study the effect of cassava on Mycorrhiza on a subsequent maize crop in a laboratory (Saidou, in press) because the knowledge applied in this specific context is not available. Such research could be carried out at any time -either at the start or when it is realised that some (elementary, disciplinary) information is still lacking, or half-way through, when an unexplained puzzle arises.

The analysis of the two external case studies emphasized that the choice of the categories of farmers who were involved in the field experiments impacted on the utility of the research process and eventually on the degree in which it could impact on resource-poor farmers' livelihoods. An example is gender. In the soil fertility case, for example, men were explained how to sow crops grown during the experiments, while women are responsible for sowing.

Issues that impact on the extent to which farmers consider the technology useful depends on the degree to which it fits in the existing farming calendar (e.g., the cases demonstrated that one of the reasons farmers preferred cowpea was because it yields early in the season and therefore leaves room for cultivating other crops. The cowpea FFS showed that Neem also has drawbacks and for example requires labour at a time it is not easily available). The example of Mucuna in the soil fertility case illustrates that single purpose cover crops are more difficult to accept than cover crops that can be used for other goals, e.g., food. It is also important how the technology impacts on existing relations (e.g., jealousy, perceived existence of witchcraft) and people's cosmovision (Millar, 1996).

Interventions are only useful if they positively affect the livelihoods of the resource-poor farmers and therefore allow for scaling up. Both case studies showed problems with scaling up and lessons remain to be learned about the issue.

Research is all too often either based on a scientist's preference, experience and competence, or on the government's priorities rather than the farmer's. This is especially the case if farmers have little countervailing power over research planning and design. However, if research is to benefit resource-poor farmers, it needs to be based on opportunities that exist. In other words, situations in which research could potentially have a positive impact on resource-poor farmers' livelihoods need to be identified. Alrøe (2000 in Baars, 2002: 144) suggests criteria for 'good choices'. Research:

1. *describes and makes explicit its own points of departure and the views and values implicitly used;*
2. *works explicitly with the goals and values involved and makes explicit the resource-poor farmers' needs (general);*
3. *describes choices made, the limitations and constraints involved and the areas covered;*
4. *is positioned within a larger perspective, to allow different users to frame the research.*

These criteria (e.g., mainly concerning the making of explicit choices, the limitations and the frames at departure) are conceptually captured by the notion of pre-analytical choices (Giampietro, 2003). Pre-analytical choices are necessary to frame a research (i.e., the boundary of the area of interest is drawn), but also to determine the possible outcomes of a research (e.g., whether sustainability is defined in terms of carrying capacity or in terms of an equilibrium between different groups of land users determines the achievable outcomes of a study). It is essential, therefore, to reach agreement with respect to the choices made, not only amongst scientists, but also amongst other stakeholders (e.g., local government agencies and farmers). Not only scientists make pre-analytical choices; also farmers have a frame of mind in which they situate the intervention. Most of these choices are made at the start, though some are made in other phases. Pre-analytical choices in other phases are made either at a lower scale or (adapted) because an initial situation is changing (as it usually and continuously will). Pre-analytical choices commonly made at the macro level include the selection of research locations, the inclusion and exclusion of scientific disciplines, building the organizational structure of the project (e.g., the nature of the organisations involved, the choice for a specific type of researchers, for example PhD researchers), the choice for a research entry point (e.g., cropping systems) to be studied and of genuine problems.

From the analysis of the two external case studies, a number of topics was identified: (1) the need to identify a relevant set of stakeholders, (2) the need to clearly reflect the different perspectives and interests of stakeholders, (3) the need to recognise heterogeneity amongst farmers, (4) the need to clarify the 'problem situation' and (5) to specify the relevance of the research to people's livelihoods.

Following the principles of grounded theory, the analytical framework was 'tested' on two case studies beyond the CoS Programme and the fine-tuned framework will now be used to analyse the experiences in CoS.

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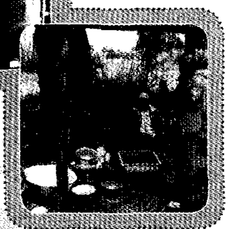
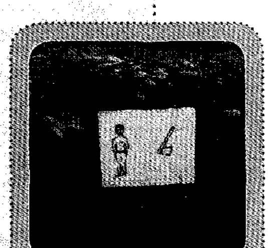


BLOCK 3

ANALYSING THE PATHWAY FOR SCIENCE IMPACT OF THE CONVERGENCE OF SCIENCES PROGRAMME



CHAPTER 6

Grounding agricultural research in resource-poor farmers' needs: A comparative analysis of diagnostic studies in Ghana and Benin

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Abstract

Eight researchers from Ghana and Benin, with different backgrounds but all co-operating within the Convergence of Sciences programme, conducted diagnostic studies as a first step of their research aimed at developing technologies together with resource-poor farmers. The purpose of including diagnostic studies was to increase the likelihood that the resulting technologies would be grounded in the needs and opportunities of these farmers. To better understand the potential of diagnostic studies for improving the contribution of agricultural research to farmers' livelihoods, a comparative study was conducted of the diagnostic studies carried out by the eight researchers. This research on agricultural research was participatory in that its results were arrived at in consultation with the eight researchers. The comparison revealed that diagnostic studies identified and established forums of stakeholders, especially of farmers, who were to play key roles in the co-construction of knowledge during the field experimental phase that followed the diagnostic studies. The diagnostic studies gave farmers a say in the design and conduct of the experimental phase which allowed them to influence the research process in the direction of developing and testing technologies that work in their circumstances and that satisfy their needs and priorities. In addition, the diagnostic studies have led to transparent choices with respect to the selection of sites, farmers and experiments. Furthermore, the conditions for negotiation were created. Finally, the diagnostic studies played a crucial role in making the partners within the Convergence of Sciences programme aware of the importance of contextual framework conditions in determining the relevance of the project.

Additional keywords
Research on agricultural research, participatory technology development, innovation, co-construction of knowledge

Introduction

The Convergence of Sciences (CoS) programme tries to contribute to agricultural development and poverty alleviation of small-scale farmers by creating convergence in technology development. Convergence should take place between natural and social scientists and between societal stakeholders (including farmers) and scientists. The Convergence of Sciences programme has deliberately included diagnostic studies in the design of each of eight field experimental studies that aim to develop technologies together with resource-poor farmers in Ghana and Benin. The purpose of including a phase of diagnostic study was to increase the likelihood that the eight technology development efforts were grounded in the needs and opportunities of their intended beneficiaries. The rationale for the diagnostic studies has been explained by Röling *et al.* (2004). This article focuses on the question whether the diagnostic studies made a difference.

The present article uses the eight diagnostic studies as case studies to carry out an exploratory and comparative analysis. The focus of this analysis was not the content of the eight diagnostic studies, but *research on research.* What was the role the diagnostic studies played in the eight studies? How did inclusion of a diagnostic study in the design of each of the research projects affect the entire project? At the time of writing, the experimental work with farmers was still in full swing. So it was impossible to use criteria that were based on the quality of the innovations that each research project produced. This meant that we needed to develop other criteria to be able to answer the main questions this article addresses: Was including the diagnostic study worth the trouble? Including a diagnostic study in a PhD research project is a considerable investment in time and effort. The eight comparable studies that started all at more or less the same time had similar purposes and were conducted in similar circumstances. They provide a good, if not fairly unique opportunity to systematically examine the added value of diagnostic studies, especially with respect to their impact on the process of making pre-analytic choices (Giampietro, 2003). As we saw in Röling *et al.* (2004), pre-analytical choices were made prior to actual experimental technology development work. Such choices are inevitable and neither good nor bad in themselves. However, it is important to make them explicitly and deliberately because they determine the research design, and the feasibility and acceptability of the innovations developed with farmers. The purpose of the diagnostic studies was most of all to make explicit choices with respect to the key issues that determine the extent to which the research effort leads to useful outcomes for the intended beneficiaries.

Our examination starts off with a description of the methodology on which this article is based. It was a challenge to carry out research on research that led to outcomes that were recognized by the main protagonists, the researchers themselves. The article then describes some issues relating to how the diagnostic studies were carried out in the two countries. Our fieldwork made apparent some aspects of the implementation of the diagnostic studies that had escaped notice at first and that we must report here. Then we present a framework for comparing the eight diagnostic studies and use it to carry out the actual comparative analysis. The article ends with conclusions and some suggestions for further research.

Before we continue, we would like to emphasize that this is very much an exploratory effort. Although the CoS programme provided a rare chance to compare eight diagnostic studies that were carried out under similar conditions, we are still dealing with eight different efforts in two different countries. Our data are not suited to quantitative, let alone statistical analysis. We provide insights that hopefully stimulate reflection on the importance of including a diagnostic phase in agricultural research and of negotiating pre-analytical choices with farmers.

Also, this research is part of a broader PhD project that aims to identify factors that allow research to benefit resource-poor farmers. The PhD project analyses case studies to draw lessons for research and uses the key issues derived from these studies in analysing the experiences with the CoS programme, which deliberately experiments with innovative types of research. The study belongs to the whole field of tradition on science and technology (Kuhn, 1970; Knorr, 1975; Chambers & Jiggins, 1987; Funtowicz & Ravetz, 1993; Engel & Salomon, 1997; Latour, 2001).

This article was written by members of the CoS programme. We have tried to be reflective and self-critical but that effort cannot replace the critical examination of a disengaged outsider. Our article has been thoroughly reviewed by external referees, and a further external review of our analysis is foreseen in a later phase of the programme. The advantage of the approach taken in this article is that it is the outcome of a collective effort in the sense that the eight researchers and some of their supervisors collectively have gone through the article and amended it in long discussion sessions. In that sense, this article is an account that reveals how the protagonists themselves experienced the diagnostic studies. Such an account has the advantage of disclosing motivations, reasons and experiential learning, but the disadvantage of possible bias and self-interested selectiveness.

The researchers who carried out the diagnostic studies and their topics per country are summarized in Table 1 for easy reference.

Table 1: The topics and the main diagnostic-study researchers per country.

Benin	Integrated pest management (cotton)	Antonio A.C. Sinzogan
	Soil fertility management (e.g. using cassava in the rotation, impact of land tenure on soil fertility management)	Aliou Saïdou
	Weed management (Striga in sorghum, spear grass)	Pierre V. Vissoh
	Genetic diversity management (cowpea and yam)	Afio Zannou
	Integrated crop management and institutional analysis (cocoa)	Emmanuel N.A. Dormon
	Organic pest and disease management (cocoa)	Godwin K. Ayenor
	Soil fertility management (e.g. cassava in the rotation, impact of land tenure on soil fertility management)	Samuel Adjei-Nsiah
	Genetic diversity management (sorghum), role of sorghum in livelihood strategy	Comfort Y. Kudadjie

Materials and methods

The collection of data for the exploratory comparative analysis reported below was quite extensive. The task was not made easier by the fact that the written accounts of the diagnostic studies that were analysed had the same deadline as the present article. In other words, a systematic comparison of the written accounts was not possible until quite late in the process. Several methods of data collecting were deployed. These include:

1. *Participant observation by the senior author as a member of the CoS research team gave her a thorough insider understanding of the overall design and process in general terms before and during the diagnostic studies.*

2. *Visits to the individual researchers, including participation in their fieldwork with farmers and in their inter-institutional and validation meetings. Also direct observations were made, but for logistical reasons this was only possible in the case of the four Ghanaian researchers.*

3. *Individual semi-structured interviews and focus group discussions with the researchers were conducted.*

4. *A Strengths-Weaknesses-Opportunities and Threats (SWOT) analysis of the diagnostic studies was undertaken with a focus group of the researchers. A difficulty encountered was the protectiveness of some researchers with respect to their results in the early phase of their PhD research. The results of the SWOT analysis were validated through a feedback session with a wider audience.*
5. *Semi-structured individual interviews were held with supervisors within the CoS programme about experiences with, and characteristics of the diagnostic studies.*
6. *The written reports on the diagnostic studies were systematically compared, using qualitative interpretative content analysis methods.*
7. *The findings on which this article is based were submitted to the criticism of the researchers. The senior author developed a framework for the comparative analysis of the diagnostic studies. She then compiled answers for each topic of the framework for each researcher as she saw it. This compilation was fed back to the researchers for verification and discussion. In addition, previous drafts of this article were distributed for criticism and ideas.*

The key content of the article is the systematic comparative analysis based on a number of criteria that were derived from various sources. In the first place, we used the criteria that emerged from the work of Van Schoubroeck (1999), Hounkonnou (2001), Tekelenburg (2002) and others (see Röling *et al.*, 2004). The senior author also participated in a case study of an entirely different project (Nederlof & Dangbégnon, in press) that sensitized her to key issues involved in making pre-analytical choices and the consequences of misconceived choices for the outcome of an entire research project. But the comparative framework that we used was also elaborated on the basis of what emerged from the data. This approach gives our comparative framework a recursive and exploratory character. In other words, our comparative framework was not *tested*, but *emerged* from the comparison and should be seen as a result of our study.

The framework for comparison

Based on the work of Tekelenburg (2002), Röling *et al.* (2004) suggest the following key questions that need to be answered for participatory experimental technology development with farmers to have a development impact. These questions should guide decisions about key pre-analytic choices.

1. *What are useful abiotic and biotic relationships (result of fundamental research)?*
2. *What is the best technical means (result of applied research)?*
3. *What can work in the context (taking into account e.g. markets, input availability, agro-ecological zone and other aspects that affect opportunities and potential for innovation at the macro level)?*
4. *What can work in the farming system (taking into account e.g. labour availability, land tenure and access to markets, at the micro level)?*

5. *What will be acceptable to intended beneficiaries (taking into account e.g. culture, priorities and preferences)?*
6. *Can the innovations that were produced be scaled up?*

These questions were used to develop a framework for comparing the eight diagnostic studies. This was not a straightforward exercise. Since the experimental work had not been completed at the time of writing, there was no evidence for many of the above questions. For example, it had not been proved that the diagnostic studies had identified innovations that can work in the context (question 3). This meant that we had to rely on categories for the framework that could be considered as proxies or that indicated processes that could possibly lead to the desired outcomes implied by the questions above. The following are the categories of the comparative framework that we settled upon:

1. *Purpose of the diagnostic study in the research process. How was the diagnostic study used for subsequent interactive experimental research?*
2. *The methodology used for the diagnostic studies (criteria for selecting research sites and (categories of) farmers; procedures for entering communities, including the intermediaries used to approach local people; extent to which multiple stakeholder were engaged).*
3. *Extent to which the context was taken into account in the diagnostic studies (e.g. economic and ecological conditions, ethnic diversity, policies, and wealth differences in the community).*
4. *The process for negotiating the experimental research programme with farmers and other stakeholders that was used in the diagnostic studies (to the extent applicable, given the phase of the diagnostic studies at the time of writing).*
5. *Interaction between the technical and socio-economic domains. How did the involvement of social and natural supervisors influence the research process?*
6. *The extent to which the diagnostic studies led to change in the design of the research proposal, and the aspects that were involved. (We look at this item in the concluding remarks to this article).*

These categories provided us with the best information that we could obtain at the moment about the kinds of pre-analytical choices that were made and the processes involved in making them.

As for the way of collecting information on each of these items, we had to rely on opinions and reasons, especially those of the eight researchers whose spoken and written testimony we used to gain insight into their respective diagnostic studies. We used a participatory procedure, in that we developed an initial list of observations based on our understanding of each of the eight. We then submitted this list, specified for each diagnostic study, to the eight researchers, adapted the list on the basis of their reactions and re-submitted the list to their scrutiny and intensive discussion during a CoS meeting in April 2004.

Background to the diagnostic studies

As explained by Röling *et al.* (2004), the diagnostic studies were influenced by the technographic studies that preceded them. The importance of the technographic studies for several of the pre-analytical choices made in the CoS programme became clear only in hindsight and is therefore discussed here. The diagnostic studies were carried out differently in Ghana and Benin, so a short description of the processes in the respective countries precedes the comparative analysis.

Technographic studies

Technographic studies (Richards, 2001) were included in the CoS programme to identify domains and opportunities for innovation at a macro level. So the technographic studies represented an opportunity for the CoS programme to make systematic and explicit pre-analytical choices before the eight research programmes had even started, although, as we shall see, the timing of the reporting on the technographic studies and the start of the eight diagnostic studies did not always allow the latter to optimally benefit from the technographic studies.

The technographic studies in both countries focused on three categories of crops by level of institutional interest: public, private and grassroots crops (Anon, 2004). The choice to divide crops according to sector or level of institutional interest was a pre-analytical choice in itself. Alternatives would have been to choose according to agro-ecological zone, farming system, administrative boundary, gender sensitivity, poverty, food security impact, etc. Table 2 presents the characteristics of each category of crops.

Dividing crops according to level of institutional interest allowed the CoS programme to capture a diversity of theatres for agricultural research. An implicit advantage of selecting different crops was the diversity of agro-ecological zones that were covered. The choice of crops was deliberately intended to also allow comparison of similar crops across the two countries with their different, i.e., Anglophone and Francophone traditions. The disadvantage of an approach based on crops is that it remains to be seen whether it allows the 'technological landscape' (Richards, 2001) to be understood. For example, a focus on crops might well detract from a systems-based understanding of the complex livelihood strategies that small-scale farmers usually rely on.

As it was, the decision was made that the technographic studies would focus on the crops chosen. The technographic studies were not carried out by the eight researchers who conducted the diagnostic studies, but by CoS senior research staff contracted for the purpose. At the time, the eight researchers were engaged in preparing their proposals and their theoretical and methodological chapters. This did not always allow for a perfect connection between technographic studies and diagnostic studies.

The eight researchers were asked to focus on one of the crops studied during the technographic studies. For some this meant they had to drop preferred subjects and accept the CoS collective decision. As already mentioned by Röling *et al.* (2004), this led to replacement of cashew by cocoa, tomato by sorghum, and banana by cassava. The narrow focus on *one* crop did, in one case, lead to an initial inability to focus on the shifting relationship *among* crops, which turned out to be more important for understanding the dynamics of the innovation strategies of farmers (Kudadjie *et al.*, 2004).

Three major innovation domains were chosen, taking into consideration the findings of the technographic studies, interest and background of the PhD researcher and the university departments involved. These domains related to (1) pests and diseases, including institutional issues impacting on integrated pest management (IPM), (2) declining soil fertility, including emergence of pernicious weeds, and (3) genetic diversity management by farmers and the introduction of improved varieties. A clear relation was assumed between the category of crops chosen for the technographic studies (e.g. public, private and grassroots) and the domain identified for the eight studies. The researchers working on a public crop all focus on IPM, a combination that is understandable given the fact that the use of pesticides, and hence cost reduction through developing alternatives, is especially relevant in public crops. The researchers who work on the 'grassroots crops' focus on genetic diversity management, while those working on soil fertility management and weeds initially focused on private crops.

Table 2: Categories of crops and their characteristics.

Category	Role in the rural household economy	Principal stakeholders	Nature of intervention
Public crops (cocoa, cotton)	Cash crop	(Partly) in the hands of the state	Intensive public research and extension
Private crops (cowpea)	Cash or food crop, important in rural areas	Private commercial initiative	Controlled by private actors (development organizations, NGOs, and traders)
Grassroots crops (sorghum)	(Formerly) main food crop	Crop for the poorer strata of society	Private and public development organizations pay little attention; relatively small research investment

The initial relationship between the industries chosen in the technographic studies and the major domains explored by the eight researchers is illustrated in Table 3. The diagnostic studies led to a considerable adaptation of this initial 'neat' scheme. For example, soil fertility and weed researchers included grassroots crops as an outcome of both the technographic studies and their own diagnostic studies. The public-crop researchers had to consider weeding as part of an IPM approach. And the grassroots crops could not be fruitfully considered without taking cash generation into account.

The four Beninese researchers preceded the Ghanaian ones in developing research proposals as a requirement for enrolling in the CoS research programme at a time when the findings of the technographic studies were not yet available. So the results of the technographic studies only reached the Benin researchers when they were in a more advanced stage of proposal writing than in the case of Ghana. It would, of course, have been desirable had the technographic studies been concluded before proposal writing by the eight individual researchers so as to help focus their studies on problematic issues and opportunities for innovation. Proposal writing in an early stage of research was a prerequisite for enrolment in a research programme. This requirement obviously conflicted with a process that grounds research in farmers' opportunities and needs. It was an institutional constraint that emerged from a blueprint, rather than a process approach to a research *project* cycle (see Röling *et al.*, 2004).

Experiences in Benin

In Benin a substantial number of both supervisors and CoS researchers was involved in a previous research project in collaboration with Wageningen University, called the 'Cowpea IPM Project'. One of the four Benin researchers actually had been employed in the diagnostic phase of this project. All other researchers were also aware of the Farmer Field School approach used in that project through numerous exchanges and written background information (Anon., 1999; Kossou *et al.*, 2001). Considered a success, the Cowpea IPM Project took on the character of a 'model' for the CoS project in Benin.

Table 3: From industries to domains for innovation needs: the initial scheme before and after the diagnostic study (DS).

Category of crop	IPM[1]		Soil fertility		Genetic diversity	
	Before DS	After DS	Before DS	After DS	Before DS	After DS
Public crop	X	X				
Private crop			X	X		X
Grassroots crop				X	X	X

[1]IPM = integrated pest management.

The Cowpea IPM Project included a diagnostic phase comprising two steps. During step one, villages for the study were selected on the basis of such criteria as the importance of cowpea production and the absence of other projects. During the second step, researchers followed the crop and the farmers during an entire growing season to document farmers' current practices, perceptions and knowledge. The purpose was to scale up promising local innovations. The first step was called 'exploratory diagnostic' and the second 'in-depth diagnosis'.

Other sources of insight used by the four Benin researchers were on-farm research approaches (Werner, 1996; Mutsaers *et al.*, 1997; Defoer & Budelman, 2000). Furthermore, the experience on diagnostic studies in Benin was coloured by the experience with FIDESPRA, later called FAR (Formation à l'Appui à l'Auto-Promotion Rurale). Since the 1990s, a number of the current CoS supervisors working for the Department of 'Economie et Sociologie Rurale' of the *Université d'Abomey-Calavi* had been involved in this training course designed to introduce development workers, policy makers and academics to participatory approaches in development planning and technology development. The first step in the course was a participatory diagnostic using Rapid Rural Appraisal tools. The social science supervisors of the four Benin researchers facilitated a considerable number of such diagnostic exercises. The four diagnostic studies in Benin benefited from this experience.

In all, the diagnostic studies in Benin were based on a two-step approach in which the first phase served the purpose of identifying major constraints on production at a regional (provincial) level and of selecting villages for future research intervention. The second phase consisted of an exploration of the situation in one or more key villages selected after the first stage for further intervention. In line with the two-step approach, most of the Benin researchers reported especially on the exploratory phase and, at the time of writing, were undertaking or finalizing the in-depth analysis of the villages selected for further research intervention. Only some of the results of the second phase were reported in the articles on the diagnostic studies (Röling *et al.*, 2004). For example, at the time of writing, in some studies negotiations with selected farmers about the ways forward in the experimental phase were still in progress. Due to the replacement of one of the Benin researchers, the diagnostic study on cotton production (Sinzogan *et al.*, 2004) started much later than the other ones so that the diagnostic study could not report on the phase of negotiation with farmers and plans for further research. This makes the diagnostic study unsuitable for the comparison on some of the criteria used below.

Experiences in Ghana

The experiences with diagnostic studies in Ghana are diverse. No general meetings with the researchers and their supervisors were organized to discuss the diagnostic studies, but support was given to them individually. Based on the results of the technographic studies, the four Ghanaian researchers immediately proceeded to one or a few villages to explore in detail the situation regarding the subject areas that they had finally decided to work on. So in Ghana a one-step approach was followed, mainly inspired by Van Schoubroeck (1999) who did an 'incidental diagnostic study' when he realized that the topic that had been assigned to him was not the most relevant one for the farmers he was supposed to work for (for more details see Röling *et al.*, 2004). In addition, some researchers used insights from Defoer & Budelman (2000) for their methodology. The Ghana group took the village entity as an entry point and subsequently explored the problematic domain and negotiated common grounds for research with farmers and other stakeholders in the selected communities.

Comparison of experiences in Ghana and Benin

The CoS research approach was not cut and dried during the first year of the project. Due to its process-driven nature and the joint learning process that emerged, the approach evolved from one stage to another. As a result, the understanding and operationalization of the technographic studies and diagnostic studies differed considerably between the two countries, which in turn meant that the interactions within the CoS Working Groups (i.e., the supervising faculty) and between the Working Groups and the researchers also differed. The diversity in approaches to diagnostic studies among the Ghanaian researchers can be attributed both to the little previous experience of the Ghana group with diagnostic studies, and to the smaller influence of the Ghana Working Group on the four researchers' diagnostic studies. This created space for the researchers in Ghana to innovate in their diagnostic studies, while, as a result of the greater involvement of the supervisors and the greater experience with diagnostic studies, those in Benin followed a more uniform approach.

Whereas, in general terms, the Benin technographic studies identified domains of innovation needs in different pre-selected industries (Anon., 2004), the Ghana team looked at promising existing innovations in different industries in some selected regions and villages (Abekoe *et al.*, 2002, Sakyi-Dawson *et al.*, 2002). For example, the technographic studies in Ghana identified a village in which an interesting innovation had been developed (using cassava for soil fertility improvement as an adaptation to the need for continuous cropping under population pressure). One of the Ghana researchers, Adjei-Nsiah, is now working in that village. In other words, the Ghana technographic studies can be compared to the exploratory phase of the diagnostic studies in Benin.

Findings: the comparative analysis

Variation in objectives of the diagnostic studies

The diagnostic studies differed in several respects whilst in other they shared purposes. All researchers mentioned that the diagnostic study helped to create a responsive environment for their subsequent experimental work. Their presence in the village(s) and their interest in the lives of the local people established good rapport. The diagnostic studies in both countries helped to identify possible linkages between social and technical issues and to understand the context in which the proposed research topic is embedded. This in turn provided some initial insight into the relationship between the activities proposed by the researchers and the extent to which these would lead to innovations that would work in the context and farming system and would be acceptable by local people. We elaborate on these points below.

As explained above, the diagnostic studies in Ghana and Benin differed in a number of respects. In Benin the diagnostic studies explored the production systems in relation to the topic chosen. This exploration included farmers' current conventional and innovative practices and baseline information on their knowledge on the topic. Understanding production systems helped to establish whether the chosen topic was indeed an issue. So an important purpose of the diagnostic studies in Benin was to crosscheck the importance of the topic with the farmers. Also, the diagnostic studies helped to select a specific representative village or villages for further interactive research. During the in-depth exploration within the selected village(s), specific experiments were negotiated with the local people, often based on innovative practices developed by farmers themselves.

In Ghana the diagnostic studies were used to identify critical problems with respect to the industry and topic selected, and to explore causes of these problems in a village or villages in order to negotiate agreements about experiments with stakeholders. In some cases the importance of the topic was confirmed, whereas in other the subject was negotiated through demonstrating the rationale behind a certain choice. The diagnostic study by Ayenor *et al.* (2004) provides an example of a negotiation process, including the use of a cage experiment that convinced collaborating farmers of the importance of the research topic chosen (capsids in this case). In Ghana, a small sample of villages was selected for thorough investigation. The village(s) chosen was (were) not necessarily representative for a larger population because the criteria were not cross-checked with a larger sample of villages. The diagnostic studies were mainly used to establish aspects of the topic that were considered important by farmers and to determine what farmers would like to do within the scope of the topic selected. In summary, the diagnostic studies in Ghana aimed (1) to justify the choice of a problematic domain, (2) to ground the subsequent phases of the research in farmers' needs through negotiation of the purposes of, and activities for inclusion in subsequent experiments, and (3) to reach agreement on the roles of the different stakeholders.

Variation in methods of engaging farmers

Selecting communities

Selecting communities in which to work required careful attention. All PhD researchers started with a review of available documents. In addition, expert advice was sought to determine the possible areas for research, based on the extent to which the crop chosen was cultivated and on whether the topic seemed relevant. In one case (Adjei-Nsiah *et al.*, 2004), the choice for the village was suggested by the technographic studies. Additional communities were added as a result of the diagnostic study, which revealed differential soil fertility management strategies between migrants and natives, who were found to be living in different communities. Soil fertility management strategies appeared to be strongly related to security of land tenure.

Some researchers went to all selected areas while others visited only some and consulted mainly with the extension services to select a shortlist of villages. Criteria used to select villages were, amongst other ones, the importance of the crop in terms of production, accessibility of the site during the whole year, and proximity of a research institute. Implicitly, the quantity of the crop produced was considered an indication of the importance of the crop for the farmers, although that importance might not be a good reason for investing in research. It assumes that increased production is desirable, which may or may not be the case from the point of view of the farmers. Additional incidental criteria for selecting rural communities were previous project interventions (mainly with respect to cocoa and cotton), diverging agro-ecological conditions, the influence of neighbouring countries, and the proximity to a market (mainly used in the case of grassroots crops). The enthusiasm of farmers to collaborate in subsequent participatory experimentation was considered an important criterion for selection of one or more villages by all researchers.

Compared with focusing immediately, starting in many villages and then zooming in on a few has both advantages and disadvantages. An advantage is that it was more likely that the researcher ended up with villages in which he/she could respond to farmers' needs in terms of having something to offer. In addition, the village was more likely to be representative for a larger population, which was relevant from the point of view of replication. A disadvantage was that work in several villages in which no future activities were undertaken contributed to the already bad image of scientists. One of the researchers (Saïdou, personal communication) described the surprise of the villagers when he returned for follow-up work: *"We thought you were lying, just as all of those who preceded you".* In one case, a researcher who had selected areas that were very far apart was told by his supervisors to focus on a more manageable area from a logistical (cost, time, transport) point of view.

One researcher in Benin, Sinzogan, started later than the other ones. The main lesson he claimed to have learned from his colleagues was that more than one village needed to be explored to ensure representativeness but that studying many villages was time-consuming and created expectations that could not be met. He therefore selected seven villages for exploration and two for further research.

Approaching local people

Approaching the local people required careful consideration. In general, each of the PhD researchers started the diagnostic study fieldwork with a community meeting, i.e., with a group selected by the village chief, the president of the 'Groupement Villageois' (GV), or the extension worker (see below). This group was asked to answer some preliminary questions to determine the potential for collaboration. In all cases, this first community meeting was used to establish whether there was a ground for collaboration.

Beyond this initial interaction, the introduction to the villages in Ghana was different from that in Benin due to differences in the institutional context. In Ghana, government extension workers were an evident entry point into the community, while in Benin the (cotton) extension service (Centre d'Action Régionale pour le Développement Rurale – CARDER), had recently been reduced in size and its tasks partly delegated to farmers in the GVs. In Benin the GVs were therefore used as an additional point of entry.

In Ghana the extension agent usually introduced the researcher to the village chief who then organized a community meeting. The extension worker was usually present during the first meeting. Introduction through an agricultural extension agent can affect the nature of the issues raised by local people. This was demonstrated by Dormon *et al.* (2004) who experimented with different ways to approach the local people. Three modalities were used. In area X all cocoa farmers were invited to the meeting; in area Y the extension agent selected two farmer groups, while in area Z the Chief selected representatives from different hamlets. Depending upon the method followed, different results were obtained. In area X, involving the whole community, socio-economic issues dominated the discussion about the causes of low cocoa yields, including the lack of access to electricity (leads to emigration of youths, labour scarcity and hence lack of, for example, plantation maintenance). In area Y, involving an extension agent, technical agricultural issues dominated the discussion. The group in area Z selected by the Chief had to be dropped because different people kept turning up to attend the meetings.

Considering their likely long-term presence in the area, the Ghana researchers also contacted other local authorities such as village elders and the assemblyman (local government representative) through courtesy calls and involved them in meetings with farmers.

In Benin the researchers often consulted the CARDER office for short-listing potential villages. The CARDER agent often introduced the researcher to the president of the GV, who in turn organized a community meeting. The extension worker did not always physically accompany the PhD researcher but in some instances sent a message to announce the arrival of the researcher. The village chief was not always present at the meeting and the community meeting often gathered members of the GV.

Since these GVs had been started with the express purpose of distributing inputs for cotton production and later for all crops, this method of selection favoured relatively better-off producers, not necessarily average or poor farmers. Also, using extension workers to select farmers is likely to lead to a biased selection since extension workers tend to interact with the top 10–20% of the farmers (Röling, 1988).

Most of the CoS researchers introduced themselves as students although farmers do not always make a difference between researchers, extension workers and students. Adjei-Nsiah (personal communication) explained that the farmers saw him as an extension worker because "*only extension workers work closely with the farmers*". Some cotton farmers held Sinzogan (personal communication) responsible for delayed seed cotton payments. A village authority had to intervene to explain that the researcher was 'just a student', who did not have influence on such matters. Farmers assessed the role of the researchers and the benefit they might derive and subsequently oriented their choices vis-à-vis the researcher accordingly. Farmers might think that the researcher could solve some of their problems or provide other short-term benefits (fertilizers, contacts with influential people or organizations, etc.). One of the Ghanaian PhD researchers, Dormon, actually did have a double role in that he did his research in his (widely-known) capacity as an employee of the Ministry of Food and Agriculture. Most PhD researchers discussed the results of their diagnostic studies with the community, sometimes as part of further action planning for the research.

Some researchers spoke the local language and could therefore directly interact with the local people. In other cases the researchers could not speak the local language. This language barrier sometimes caused communication problems and researchers had to rely on an interpreter.

Selecting farmers

In all cases, the farmers participating in the diagnostic studies were selected from the farmers participating in the community meeting. Either the community meeting suggested farmers to be involved or volunteers were asked.

Multiple stakeholder process

The Ghana researchers used the diagnostic studies to establish forums for collaboration with other stakeholders, invited from the start to meetings to reflect on the research proposed. The mechanism used was an inter-institutional meeting organized every three months. The Benin researchers considered such multi-stakeholder processes beyond the scope of the exploratory phase of the diagnostic studies and were later exploring possible ways of collaborating with a wider set of stakeholders. In two of the diagnostic studies, a public research organization had a direct role (Ayenor *et al.*, 2004; Kudadjie *et al.*, 2004) and a scientist from the organization regularly attended the meetings with the experimental group and participated in negotiating the research design.

Towards farming systems that work in an existing context

The diagnostic studies helped the researchers to understand the wider context and the importance of the context in determining what could be possible improvements in the problem situations identified.

In the cotton and cocoa sectors of Benin and Ghana, respectively, farmers were accustomed to external interventions through projects, regulatory measures, or the attempted introduction of science-based innovations (e.g. Anon., 2004). So innovation processes in these public crops often take another course than in the case of, say, crops like cowpea or sorghum for which most innovations originate from the farmers themselves. In the case of innovation in export crops, different scale levels are involved. A researcher working on an export crop has to negotiate with a large group of stakeholders with diverging interests. Farmers tend to be little motivated to make a contribution themselves. For example, in the case of Dormon *et al.* (2004), the farmers argued that the government uses the *abusa* system in dealing with them, i.e., they feel like sharecroppers in their own plots as a result of the high taxes imposed on farmers' cocoa returns. As a result, they are not very interested in investment and maintenance. In the case of cotton, the responsibilities for marketing and input supply have recently been transferred to the private sector, but farmers in that sector experience the consequences of the reorganization of the sector in the form of late payments and other inconveniences. In recent years cotton prices have collapsed, partly as a result of export subsidies by the USA and Europe and partly because of the enormous increase in cotton exports from China.

Also the cocoa sector can be called dynamic, but in a more positive sense. The producer price has been increased but extension tasks have been shifted from the specialized Cocoa Services Division, a subsidiary of the Ghana Cocoa Board (COCOBOD), to the general public extension service. Mass spraying with pesticides and a hitech programme (e.g. a credit-based programme for fertilizers and inputs to increase cocoa production) have been introduced. These changes have created a situation in which farmers find it again in their interest to innovate.

The importance farmers attribute to certain crops depends on the time of the year in which the questions are asked. In both genetic diversity studies (Kudadjie, personal communication; Zannou, personal communication) farmers tended to attribute more value to grassroots crops at the end of the dry period when food crops are scarce and many traditional and cultural ceremonies take place, than at the time of harvesting when financial benefits are derived.

Both soil fertility studies (Adjei-Nsiah *et al.*, 2004; Saïdou *et al.*, 2004) showed the importance of the land tenure system. Even though the specific tenure systems and resulting regulations differ in the two countries, their impact on farmers' willingness to invest in soil fertility was equally evident. This effect was not observed for weed management (Vissoh *et al.*, 2004) probably because ethnologically homogeneous villages were selected. But the same weed study did show that because of low soil fertility farmers find that the time invested in weeding does not result in a proportional increase in yield, and does not pay as well as off-farm activities. So weeding is limited to the minimum required for subsistence production. Developing time-saving weed management strategies seems a window of opportunity for a research contribution.

Leeuwis & Van Den Ban (2004) argue that innovation often is instigated through (1) changed perceptions of reality, (2) changed aspirations, (3) changes in the social environment, (4) changes in natural or physical circumstances, and (5) changes in socio-economic or technical opportunities. The first two are seldom autonomous but often induced by changes in (3), (4) and (5), i.e., in the contextual changes. The diagnostic studies showed that population pressure and soil fertility declined. They also showed that the availability of off-farm paid employment and related labour scarcity and emergence of opportunity cost calculations, land tenure arrangements and insecurity of tenure, as well as price fluctuations, played predominant roles in determining whether the contribution of agricultural research is feasible and useful. The diagnostic studies played a crucial role in revealing the importance of these contextual factors to the researchers and made it all but impossible to ignore them in the subsequent participatory experimental work.

Negotiating experimental research programmes

A crucial proxy for such questions as 'What can work in the farming system?' and 'What will be acceptable?' is the *de facto* influence that intended beneficiaries can exert on all aspects of the research process. Diagnostic studies play a crucial role in this respect. They establish regular interaction with the intended beneficiaries, they provide opportunities for taking into account local knowledge and needs, and, most importantly, they allow farmers' veto power to be brought to bear *before and during* the experimental research and development work.

In this process, the demands of a PhD dissertation that can be defended against the objections of an academic forum and the demands of farmers are not necessarily additive and require trade-offs and risk-taking on the part of the researchers. Farmers have to make a similar calculation: 'Do we trust the researcher and invest time and energy in research, or do we go for short-term benefits?' In other words, the two parties have very different interests and it is not misplaced to regard the initial interactions as negotiations that hopefully lead to a 'contract' that is more than a compromise dictated by convenience, courtesy, or strategic calculation. The diagnostic study is a crucial occasion for conducting such negotiations. Yet, being selected as a suitable PhD candidate does not automatically mean that the researcher is equipped to conduct such important negotiations with farmers who do not necessarily understand what research is all about in the first place.

The CoS researchers differed a great deal in terms of experience and skills that could be brought to bear in such negotiations. Some were in their forties or fifties and were well known or even highly regarded in their areas of work. Others had ample experience in village work. They spoke the local language fluently, if it was not their mother tongue to begin with. Others were much younger and had less experience. For example, Kudadjie worked as a young woman with older farmers whose language she was just beginning to understand. Initially she had no means of transport and had to rely on the goodwill of others. The depth of the insights she and her co-researchers gained was testimony that such handicaps could be overcome. The fact that she was not as yet engaged in experimentation at the time of writing was partly due to the fact that her interaction with farmers and her subsequent understanding led her to totally change her original research idea. In her case, the diagnostic study played a crucial role in re-formulating the research proposal.

In three other cases the contracts with farmers were also still under discussion at the time of writing, either because the researcher started late or because the specific experiments had not yet been agreed upon. In the remaining four cases, the negotiations led to the addition of experiments to the initial ones foreseen by the researcher, based on farmers' current practices and their suggestions. Contracts also related to such issues as time for meeting (in most cases every fortnight on market day, in some cases on request of the researcher), the mutual roles and labour input, the access to experimental fields, the use of controls (usually not considered necessary by farmers) and the decision whether to experiment on collective versus individually owned plots.

In the case of cocoa, the contracts with farmers led the researchers and other stakeholders to actively intervene in the context. In Ayenor *et al.*'s (2004) case, pressure from potentially organic cocoa farmers activated the researcher and other stakeholders to avert mass spraying of the experimental area. The bankruptcy of the prospective buyer of organic cocoa removed the entire rationale from the IPM in cocoa work and necessitated urgent action by the researcher and other stakeholders to open new marketing options. Dormon (personal communication) decided that effective scaling up of his work required engaging in the development of a regular *Neem* production and distribution system.

The researchers working on genetic diversity management had more difficulties in selecting relevant issues and entering contracts with farmers. Farmers inherited extensive knowledge from their ancestors about growing grassroots crops, and their price so far did not warrant new approaches and investments. In Ghana, Guinness Breweries was experimenting with buying sorghum from farmers and this could open interesting opportunities. So far, farmers tended to replace sorghum by maize (Kudadjie *et al.*, 2004) due to the increased monetary value of maize, and as a consequence during certain times of the year considered this crop more relevant than sorghum.

An important issue is the nature of the farmers who did, in the end, determine the outcome of the research. This is an old issue. As could be expected, the diagnostic studies confirmed that communities were not homogeneous so that choices had to be made as to who should benefit from the research programme (assuming some benefit, of course). One of the interesting issues that emerged from the diagnostic studies is the importance of tenure arrangements for determining the outcomes of agronomic issues. Both migrant *and* native farmers (Adjei-Nsiah *et al.*, 2004; Saïdou *et al.*, 2004) or landlords *and* caretakers (Dormon, personal communication; Ayenor *et al.*, 2004) needed to be involved in the research in order for its outcomes to be relevant for these different categories. None of the diagnostic studies reported explicitly on efforts to include the poorer farmers. In the absence of explicit effort it can safely be assumed that the farmers involved were those who were relatively better off (Röling, 1988).

If no explicit effort was made to include women, chances were that the research ended up dealing with male farmers. Only one researcher in the diagnostic studies, Kudadjie, is female. Our analysis shows that she was the only one of the researchers who insisted on the participation of women in the research group. The male PhD researchers tended to explain the weak representation of women by cultural and social norms and values of the societies in which the work was undertaken. For example, in the case of yam (Zannou *et al.*, 2004), a constraint on including women was the cultural taboo on their entering the field when they are 'impure'. This suggests that men tend to find excuses for low participation of women and accept it as a given rather than trying to do something about it. A local development worker reasoned: "*It is because there is a tendency to explain and accept cultural practices as something that needs to be respected and should not be disputed, whilst it is rather changing such a context that will allow for innovation and change. Tolerating such a context rather contributes to keeping us poor*".

Three of the Benin researchers carried out the interactive experimental research with a selection of farmers who already belonged to a group before the diagnostic studies started (for example groups formed by the Cowpea IPM Project, the National Agricultural Research Institute (INRAB), or by a GV). Only in the case of Zannou's (personal communication) project a group was constituted specifically for the purpose of the research because no previous group existed. In Ghana, new groups were formed, based on voluntary participation of farmers often elected by the larger community to represent them in the research. Ayenor *et al.* (2004) analysed the reasons why communities elected members to represent them. In one case in Ghana (Dormon *et al.*, 2004), the group of an extension worker was used for further research activities.

Linking technical and social factors

The CoS programme deliberately aims to learn more about the link between natural and social issues, reason why each PhD researcher has both natural and social science supervisors. Whether a researcher is a natural or social scientist depends on several factors including educational background, professional experience, and importantly, his/her enthusiasm. All CoS researchers received additional training in the field in which they were considered to be weak. Nevertheless, the CoS scientists with a social science background felt they would have done a similar analysis for their diagnostic studies without the additional training, even though the training enhanced understanding of the technical content. It would be normal to assume that researchers with a social background have a basket of data-collection tools at their disposal that differ from those of natural scientists. However, the methodological tools applied by the two types of scientists seemed not to be significantly different.

Adjei-Nsiah *et al.* (2004) state that co-operation between social and natural scientists has mainly helped to generate new questions. This confirms experiences of social science supervisors who often pointed out important socio-economic aspects of the work the researchers were involved in. For example, social science researchers suggested one researcher for trying to understand how local farmers adapted their farming systems in order to successfully, it seems, cope with the historical population increase and the reduction of the fallow period. Similarly, another researcher was urged to establish the history of the emergence of pernicious weeds in the farming systems as a result of the relatively recent need to use land continuously. Social scientists have insisted that explorations of the context cannot only provide credible dissertation chapters but also essential insights. For example, a good insight into the experience with organic cotton in Benin can help in making important choices with respect to the nature of the experimental IPM work by Sinzogan.

At the start of the CoS programme it was agreed that innovation has social, institutional, economical, technical and political dimensions. Innovations can include procedures, forms of organization, new ways of interacting, and institutions (in the sense of sets of rules), as well as technologies. A comparison of the diagnostic studies on this point leads to the inevitable conclusion that most of the contracts with farmers focus on technical change. However, in a number of cases this technical change was pursued through socio-economic changes. For example, Dormon's work on setting up a system of neem input delivery will help farmers to implement IPM in cocoa. Negotiations between owners and caretakers envisioned by Ayenor would simplify pruning and weeding of cocoa to combat Black Pod disease. Increasing the security of tenure arrangements between native and immigrant farmers through the work of Adjei-Nsiah in Ghana and Saïdou in Benin could substantially improve soil fertility and the sustainability of farming.

Concluding remarks: Have the diagnostic studies made a difference?

We conclude this paper by examining item no. 6 discussed in the paragraph on 'the comparative framework'. T.W. Kuyper (personal communication) made the following inventory of the pre-analytical choices that the CoS programme made, before the diagnostic studies were even started:

1. *Science (carried out differently) matters to African farmers.*
2. *This science needs to include both social and natural science.*
3. *This science needs to include both 'southern' and 'northern' scientists.*
4. *Each individual investigation needs both the social and natural sciences.*
5. *Problems that have often been mentioned with respect to farming in Africa are genuine problems (weeds, pests, soil fertility, etc.).*
6. *Pest problems can be tackled by entomologists (and therefore virologists are not included in the programme) and soil fertility problems by soil biologists (and therefore soil chemists or plant nutrition scientists are not involved).*
7. *It is possible to understand local problems by taking a local view (the a priori choice to leave out economics and political science).*
8. *Farmers are considered as a homogeneous group with regard to issues such as migration and land tenure.*
9. *An individual scientist with a background in one domain and some knowledge in the other, supported by scientists from north and south and from social and natural sciences, can usefully tackle the issue under investigation.*
10. *Problems in the domain of the social sciences are social also in the sense that their solution depends on collective learning and experimentation.*

To this impressive list, we can add (11) the choices made through the technographic studies with respect to crops and related domains, as we mentioned earlier.

Given these choices before the diagnostic studies were carried out, what difference have the diagnostic studies made? Were they worth the effort? Have they substantially changed the earlier intentions of the researchers as laid down in their research proposals?
Have the diagnostic studies led to systematic and explicit pre-analytical choices in negotiation with farmers? In response to these questions, we would like to make the following points:

1. *The comparison revealed that diagnostic studies identified and established forums of stakeholders, especially farmers, academic supervisors, scientists from national research institutes, local administrators and national rulers, who were engaged in learning from a concrete experimental activity. The outcome of research will emerge from the interaction within this community and is not the end-of-pipe product of a linear science-driven process. So far, establishing such communities has not often been part of the scientific research methodologies repertoire taught in universities or used in assessing the quality of scientific contributions.*
2. *The diagnostic studies gave farmers their say in the design and conduct of agricultural research. It stands to reason that this allowed them to bend its outcomes in the direction of producing innovation that works in their circumstances and that satisfies their needs and priorities. So the diagnostic studies led to a situation in which researchers had to make a deliberate trade-off between the interests of farmers and their own interests in obtaining a doctorate. It is to be hoped that academic criteria for excellence will include the extent to which farmers were given a say. Research needs to be grounded in the needs of intended beneficiaries as much as in the scientific discourse and the traditions for constructing scientific 'facts.'*
3. *The diagnostic studies have led to transparent choices with respect to the selection of sites, farmers and, in a number of cases, to the inclusion of more experiments than envisioned at first, in one case even to a complete revision of the original research proposal.*
4. *The diagnostic studies created the conditions for negotiation that sometimes led to adaptation of the research to farmers' knowledge (e.g. including experimentation with cassava as a soil fertility enhancing crop), and sometimes to convincing farmers (e.g. the importance of capsids in affecting cocoa yields). In a number of cases, the diagnostic studies confirmed the original choices made by the researcher (e.g. the importance of weeds as an emergent problem seriously affecting farmers' livelihoods).*
5. *The diagnostic studies played a crucial role in all research projects in establishing the importance of the context for the relevance of the project. In fact, it has become clear that in the dynamic situation in West Africa, a researcher cannot afford to consider the diagnostic phase closed.*

In conclusion, we would like to make a few suggestions for further questions for analysis of the diagnostic studies that we have neglected in this article. One important question that needs to be answered relates to the cost in time and money involved in carrying out the diagnostic studies. What does the inclusion of a diagnostic study imply for the budget and time allocation of agricultural research? A second question, which can only be answered once the experimental studies have been completed, is: Does the establishment of a community of stakeholders that learns from a shared concrete experimental activity lead to outcomes that are scientifically acceptable in the traditional sense of the word? And what is gained in terms of the relevance and appropriateness of the research outcome? A further question is how researchers re-define their roles if the aim is to benefit resource-poor farmers? A final question that interests us a great deal is whether the intensive learning experience of the farmers who were engaged in the research projects leads to their empowerment, and whether it is possible to share this experience with other farmers.

Finally, this comparative analysis of the CoS diagnostic studies research process hopefully has allowed to critically reflect on the importance of diagnostic studies for enhancing usefulness of agricultural research for farmer's livelihoods. Diagnostic studies seem critically important for adequately making pre-analytical choices that shape the design of agricultural research, but as this study has shown, many factors impinge on the quality of diagnostic studies.

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CHAPTER 7

Concluding remarks: Pathway for agricultural science impact in West Africa: Lessons from the Convergence of Sciences Programme

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Abstract

The impact of agricultural research on the livelihoods of resource-poor farmers in West Africa has been disappointing. This article reports on research on agricultural research that sought to identify an alternative pathway of science that would lead to greater impact. It is based on the analysis of the work at eight pilot learning sites in the Convergence of Sciences (CoS) programme. Each site featured research for development with resource-poor farmers and other stakeholders. On the basis of literature review, we first built a perspective on the mix of research outcomes that seems necessary for agricultural research to be demand-driven and client-oriented. This perspective then served as the framework for analysis of the work at the eight learning sites. Adapted and consolidated on the basis of this empirical work, the framework represents a set of preliminary ideas for designing an effective pathway for agricultural science. The analysis shows that CoS has, in a number of diverse contexts and with respect to different crops, demonstrated that it is possible to establish vibrant multi-stakeholder learning coalitions at the local and programme levels that generate a great deal of enthusiasm and drive. It is further possible to identify promising opportunities that can be effectively addressed by agricultural research, if that research is multi-disciplinary, refrains from making constraining pre-analytical choices, pays attention to institutional aspects, and uses procedures that ensure that research is not only supply, but also demand-driven. The study fills a gap in defining the nature of the components of a meaningful agricultural innovation system. The institutional dynamics at the macro level remain to be addressed in CoS' second phase. The present paper reports on the social dimensions and methodological issues of the first phase of the Programme. The outcomes of the agronomic experiments with farmers will be reported elsewhere.

Keywords:
Multi-stakeholder learning process, Participatory Innovation Development, Ghana, Benin, Resource-poor farmers, Innovation systems, Demand-driven science

Introduction

In 2002, CGIAR commissioned a study of the causes of the low rates of adoption of agricultural research results in West and Central Africa (Stoop, 2002). At the time of writing, donors seem to be increasingly reluctant to fund international agricultural research because it is unclear how it contributes to reaching the Millennium Development Goals (Louwaars, pers. comm. March 2006). A number of recent studies focus on ways to enhance the impact of agricultural research on resource-poor farmers' livelihoods (e.g., Barnett, 2004; Pound *et al.*, 2003, *Agricultural Systems,* 2003), but so far, West Africa's farming seems to have remained largely untouched by the technologies that have been developed by National Agricultural Research Systems (NARS) and International Agricultural Research Organisations (IARO) and other organisations that have the mandate to produce these (international) public goods. This limited research impact is an intriguing challenge, and a researchable issue of the first order.

One can look at this issue from the point of view of marketing (e.g., Kotler and Andreasen, 2003) and ask why an exchange of values has not been taking place between scientists and farmers as parties in a transaction? What is wrong with the 'offering' of research and with the way it is being produced, positioned, priced, and promoted (the four Ps of marketing)? But one can also look at the issue from a soft system perspective (Checkland, 1981; Checkland and Scholes 1990), and consider farm innovation as a property that emerges from a soft system, i.e. from the interaction of a set of stakeholders who are converging towards concerted action (e.g., Bawden, 2000; Engel and Salomon, 1997; Röling and Wagemakers, 1998). This perspective provides a refreshing view on the role of the researcher as an actor in a 'theatre of innovation', who tries to improve its innovative performance (Engel, 1995). Why does agricultural research play such a limited role in the theatres of innovation in West Africa?

Such questions raise the need for developing a body of knowledge that systematically deals with the pathways of agricultural research impact, and that offers the reflective agricultural scientist and other practitioners a 'praxiology', a theoretical basis for effective practice.

In the theory that underpins most current scientific practice, science is able to 'discover' (in the sense of lifting the lid of) the secrets of nature, develop objectively true knowledge about them, apply that knowledge to the assumed priorities of increasing productivity and resource efficiency, and deliver the resulting technologies through extension for diffusion and adoption among the 'ultimate users' in a hopefully large recommendation domain. It is a supply-driven approach (e.g., Chambers and Jiggins, 1987; Röling, 1986).

This conventional approach has been challenged over the years by farming systems research (e.g., Collinson, 2000), and by participatory approaches, including participatory technology development (e.g., Jiggins and de Zeeuw, 1992). But we feel that these alternatives have not been radical enough. They have not looked at the total 'engagement' between scientists and farmers as a dyadic process. We refer to the 'pathway of science' to denote this engagement. This notion reflects the observation that science is a social institution, just as the market, justice, etc. (North, 1990; Hood, 1998; Richards, pers. com. January 2006), i.e., a set of rules, that, in the case of science, enhances the extent to which society is able to deal with uncertainty, knowledge and surprise to create human opportunity. In the present article, we attempt to design a pathway that can be effective in situations where market-propelled innovation based on the agricultural treadmill (Cochrane, 1958; van Huis *et al.*, in press) does not apply.

In our search to identify such an alternative pathway, we shall first discuss the context that affects the impact of science in West Africa. We then propose the outcomes that an effective pathway must realise by way of a preliminary analytical framework. We then use the experience of the CoS programme as a whole, and more particularly a comparative study of the eight field experimental projects within that programme, to design a pathway for agricultural research impact that can improve the livelihoods of resource-poor farmers. The article ends by considering the feasibility of institutionalising that pathway.

Particularities of the West African context

The context of West Africa poses particular challenges in designing a pathway for science. We briefly look at four points: (1) the nature of opportunity, (2) the institutional nature of innovation, (3) diversity and (4) the presumed stagnation of African agriculture.

The Nature of Opportunity

It is difficult to identify realistic opportunities for agriculture in West Africa. If we look back at the CoS experience, only one obvious opportunity stands out: the rapid drop of Ghana's global market share for cocoa convinced the authorities that they should pay cocoa farmers up to 70% of the world market price. Coupled to the collapse of the export from Côte d'Ivoire, this means that Ghana's cocoa farmers the last few years receive a much better price, which has given new impetus to their readiness to innovate[46] (Ayenor *et al.*, in press; Dormon *et al.*, in press). But the other major West African export crop, cotton, shows a different picture. The prices received by African cotton farmers have been suppressed by the rapid increase in cotton production by China, by the coming to an end of preferential trade arrangement for textile fibres in 2005, and by the subsidised dumping of American cotton on the world market (Minot and Daniels, 2002). The privatisation of cotton production in Benin has not brought greater efficiency to the cotton supply chain, but apparently only greater profiteering and rent seeking (Sinzogan, *et al.*, in press).

In food crops, the prospects are even bleaker. In West Africa as a whole, food farming is considered a legitimate target for rent seeking at the national and local levels by public and private agencies. In addition, West African food farmers have to compete with farmers in industrial countries, who benefit from more than 50 years of public investment in research, extension, education and infrastructure development. Unless they are protected, the former do not stand a chance.

This analysis means that West Africa poses special challenges for designing an effective pathway for science. Much effort is needed to identify windows of opportunity within which research can effectively make a contribution.

The institutional nature of innovation

One could go further and say that within those limiting conditions, technology availability is not the bottleneck in poverty reduction. For example, in West Africa Mortimore and Harris (2005) 'tested the hypothesis that nutrient depletion scenarios should be reflected in the long-term agricultural performance of farming systems at the macro-, meso- and micro-scales, and found that the scenarios have less predictive capability than macro-economic policy and demand-side factors'. Stretching the windows of opportunity requires institutional change. Leeuwis and van den Ban (2004) call this 'creating space for change'. Examples are enhancing farmers' countervailing power, removing 'informal taxation', reducing cheating by middlemen, creating access to market information, including transparency with respect to government deductions, and making available credit and inputs. An agricultural science that is serious in seeking to improve resource-poor farmers' livelihoods cannot escape dealing with these institutional issues. Continuing to promote technology as the sole motor of development is a recipe for irrelevance. Some of the articles in the International Journal of Agricultural Sustainability (especially Dormon *et al.*, in press) demonstrate that agricultural research with farmers can make important contributions to identifying and testing institutional change.

46 In 2003 Ghana produced 497.000 million tons of cocoa beans. In both 2005 and 2004 the figure was 736.000 million tons (FAOstat, 2005).

Diversity

The enormous diversity in cropping and farming systems, agro-ecological conditions, markets, and styles of farming in West Africa has regularly been singled out in discussions of agricultural research in the continent (e.g., IAC, 2004). The current theory that underpins the pathway of agricultural science assumes that technologies can be developed to blanket large homogeneous recommendation domains and so ensure multiplier effects for the investment in research. At the global scale, we see homogeneous commodity markets in which the most efficient producers drive out the less efficient (or least subsidised). Agricultural technology development propels innovation in such markets by introducing efficiency-inducing technologies, which create the price squeeze that forces farmers to stay on the treadmill. In West Africa, such treadmill conditions do not apply. Farming systems rely on mixed cropping, markets are fragmented, and farmers cannot compete or face such regulated markets that Ghanaian cocoa farmers believe they are labourers for the government (Ayenor *et al.*, in press). That does not mean that West African farmers do not actively produce for the market. In fact, intricate local webs of trade exist that distribute food and other products. But these increasingly fail to serve the emerging urban (super) markets because of competition, lack of uniformity, and irregular supply.

According to Bindraban and Rabbinge (2005) agriculture is characterised by bi-modal development: 'one is the worldwide system of extreme specialisation in the face of increasing liberalisation and globalisation. The other is the increasing demand for more 'natural' production systems. Without subsidies to safeguard the revenue for the other functions (of these multifunctional systems), however, these systems are not economically competitive in a liberal world.' (op. cit.: 5). With respect to the former system, 'in combination with close and remote sensing, geographical information systems and robots, the progressive precision in agriculture increases the efficiency and productivity of mono-crop cultivation. In an increasingly liberalised world this far-reaching specialisation, accompanied by increases in scale, would appear to be the only feasible development trajectory'. The latter 'forms of agriculture and land use are only economically feasible if they are subsidised, therefore if society is prepared to pay through taxes or other means for additional functions such as care of the birds and the bees in the meadows... Similar problems arise in organic agriculture' (op. cit.: 5).

This bimodal world leaves little room for African farmers. They are unable to compete on the global market in terms of mono-cropped commodities, while instead of receiving subsidies they are being preyed upon by rent-seeking public and private agents. Patrimonial networks serving African 'big men', in collusion with foreign business interests such as the erstwhile colonial powers and the present global enterprises, including the Chinese, systematically cream off the labour and other resources of African rural areas, leaving them in a downward spiral of degradation and increasing poverty (Van Huis *et al*, in press). In addition, the present scene is marked by uncertainty. 'The price of oil is making conventional agriculture obsolete' (Roland Bunch, World Neighbours, pers. com. May 2006).

The presumed stagnation of African agriculture

But there is also hope. Although a strong one-sided focus on productivity per hectare based on Western crop ecology models finds West African agriculture 'stagnant' (e.g., IAC, 2004), that predicate is mistaken. On the whole, African farmers have been able to keep up with very high population growth, even where they lack access to modern inputs, technologies and markets. The most recent figures show a very small increase in food production per head of the population, which means that African agriculture has stayed even with rapid population increase, notwithstanding the wars and other violent disruptions, the HIV/AIDS pandemic, and climate change, which have affected the continent (Jiggins *et al.*, 1996). The figures show African farmers to be innovative, and agriculture to be dynamic and adaptive to rapid change, surprises and adversity (e.g., Rey and Waters-Bayer, 2001; Hounkonnou, 2002). African farmers continue to develop indigenous solutions to new problems, for example by developing permanent land use systems to combat weeds and 'comatose soils' (e.g., the oil palm fallow of Adja farmers in Benin analysed by Brouwers, 1993).

The dynamism of African farmers does not mean that African agriculture is on a sustainable course. What it means is that the preconceived notion of stagnation, traditionalism, or resistance to change, would be a mistaken point of departure for designing an appropriate pathway of agricultural science. Hounkonnou (2002) calls this rural dynamism in Africa the one encouraging element in an otherwise dismal development scene. Yes, African farmers have been resistant to technologies proposed to them by agricultural researchers, but one cannot blame them for inappropriate technologies (Mutimba, 1997). In fact, in designing a suitable pathway of science, we can count on African farmers as eager and innovative partners, provided there is something in it for them. Ensuring that 'something' is the challenge.

The West African context calls for a different approach, one in which multiple spaces for learning are created around a diversity of technical and institutional issues, as close as possible to where the farmer dynamism is. Such an approach allows multiple agents to evolve a rich variety of possible solutions from which the most adaptive ones eventually survive.

Building an analytical framework

In developing an analytical framework that captures the relevant aspects of an alternative pathway for science, we rely on two studies. The first (van Schoubroeck, 1999) suggested the use of additional criteria, such as relevance in terms of addressing a problem that matters to resource-poor farmers, effectiveness in addressing these problems, appropriateness in terms of the feasibility of local implementation, acceptability in terms of the goodness of fit with local culture, and scalability, the extent to which the practices that emerge can be replicated by others within the prevailing conditions. Specifying the nature of the engagement between scientists and farmers, van Schoubroeck's work suggests phases of problem identification and diagnosis, of applied science, of field experimentation with farmers so as to establish effective and acceptable practices at the local level, and a phase of scaling up.

The second study (Tekelenburg (2001) developed a 'cross-epistemological management toolkit for the interactive design of farm innovation' (Figure 1). After problem identification, two pathways must be worked out: problem analysis and goal setting. Then four types of action (research and design) can be chosen at four levels of complexity. The results of these actions must be integrated into solutions for the problem.

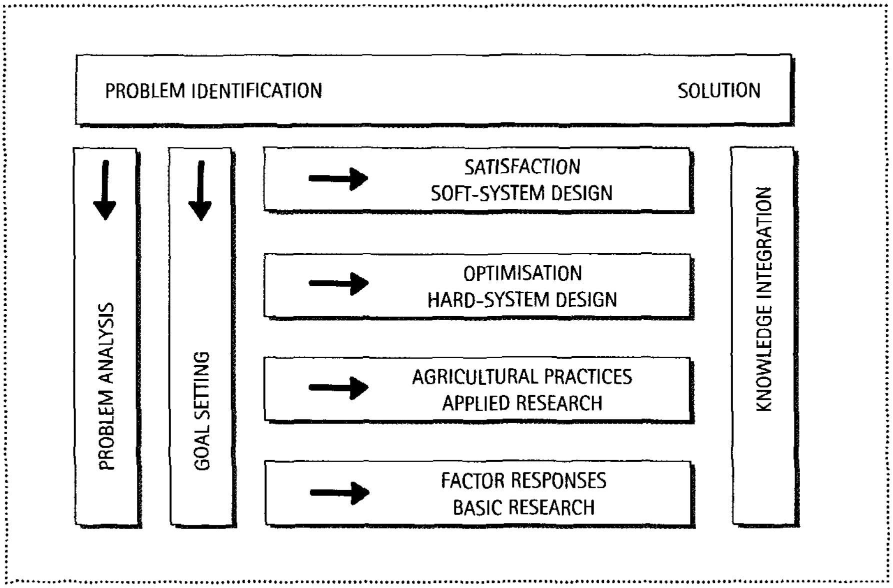

Figure 1: Management toolkit for designing interactive learning processes (Tekelenburg, 2001: 127)

Tekelenburg (2001: 31) lists the following 'expected outcomes': understanding and explanation, effectiveness, optimisation and satisfaction. Very different criteria apply in the four research and design activities that are to lead to these outcomes:

- *Understanding and explanation require objectivity, validity and reliability;*
- *Effectiveness requires developing the best means for achieving some human end;*
- *Optimisation requires adaptation to prevailing and often changing physical, ecological and economic framework conditions. The effective solution must be practicable in the prevailing circumstances;*
- *Satisfaction requires a process among the stakeholders that leads to understanding, agreement, organisation, cultural and institutional incorporation, and concerted action. Key is whether farmers have been empowered to influence the process.*

One issue that is not explicitly addressed by Tekelenburg is the identification of the opportunity that can be captured by the research contribution. Van Schoubroeck spent many months before he decided what would be the most useful deployment of him as an entomologist in Bhutan. Opportunity is a key ingredient in an effective pathway of science. Agricultural researchers usually assume that science-based technologies in themselves are the source of opportunity. Therefore they consider the development of gene technology, information technology, precision farming, etc., as the first step in the entire innovation process or pathway (e.g., Bindraban and Rabbinge, 2005). Said a prominent CGIAR researcher (M. Rosengrant, pers. com. January 2006) after the second author gave a presentation on the pathway of science: 'Let's get real and start with some technologies'. Taking technology as the first supply-driven step in the innovation process to our opinion violates the fundamentally dyadic nature of the pathway of science and ignores the many other drivers of opportunity, such as changes in institutions, regulations, values, marketing and climate (J. Jiggins, pers. com. March 2006).

The importance of starting from a realistic opportunity suggests a framework that comprises a sequence of phases. However, we opt for a mix of outcomes that must be achieved to take into account the fact that circumstances may change during the research process. Ayenor *et al.* (2004) found, for example, that the plans for export of organic cocoa collapsed during their study. Dormon *et al.* (in press) and Saïdou *et al.* (in press) ran into new problems as a result of solving old ones. Changing circumstances may necessitate a return to problem identification and analysis, and new goal setting midway the research process. On the basis of our literature review, we propose the following mix of outcomes that needs to be addressed in a pathway of science for West Africa (Table 1).

Table 1: Analytical framework: essential outcomes in the pathway of science

Outcome	Research process	Criteria	Research Intervention
Opportunity identified	Entrepreneurship Systems approach	Potential to reduce poverty	Scouting, searching, evaluating, scoping.
Space for change established	Analysis of framework conditions, diagnosis	Capturing window of opportunity	Exploration, (rapid) appraisal, sondeo
Explanation and understanding	Fundamental or basic scientific research	Objectivity, reliability, internal and external validity	On-station or laboratory research
Effective solutions	Applied and strategic research	Effectiveness in achieving some human objective	Design and experi-mentation with or without stakeholders
Optimisation of local situation	Adaptive research: translation to local situation	Appropriateness: solutions work in, or stretch, the prevailing conditions	Create a theatre for innovation with local stakeholders
Satisfaction of local needs and aspirations	Participatory goal setting, implementation and assessment	Relevance Empowerment	Facilitation of interactive process
Scaling up	Extension, diffusion and farmer education	Replicability	Curriculum development for farmer field school

We use this Table in section 7 as the framework for analysing the approach followed by the CoS Programme as a whole, and the significant 'variations on the theme' developed by the eight CoS PhD researchers in their individual projects. If CoS realised the outcomes indicated in Table 1, the analytical framework becomes a credible point of departure for designing agricultural research for resource-poor farmers.

Methodology

We address the following research questions:

1. *How did the CoS Programme, as a deliberate attempt to experiment with agricultural research that could address farmers' livelihoods, actually design its pathway of science?*
2. *What opportunities were perceived and addressed by the eight CoS PhD researchers, and how were these identified?*
3. *How did social and biological sciences converge in the studies, especially with respect to identifying institutional dimensions of opportunity?*
4. *How did the eight CoS PhD researchers achieve the different outcomes in their field experiments with farmers?*
5. *What preliminary pathway emerges from their work and what are the prospects for scaling it up?*

The senior author is the ninth CoS PhD researcher who was to compare the eight field experiments conducted in Benin and Ghana and to draw conclusions from this research on client-oriented agricultural research (e.g., Nederlof *et al.*, 2004; Hounkonnou *et al.*, 2006). We will use three levels of analysis:

1. *CoS as a whole.* The Programme used a general design that was followed by all eight researchers. This design was informed by the objective to optimise the impact of agricultural research on resource-poor farmers in a range of agro-ecological conditions and crops (section 5).
2. *Eight CoS PhD researchers.* Each researcher carried out field experiments with a group of farmers and other stakeholders. In following the general procedures proposed by CoS, each researcher developed unique 'variations on the theme' that provide additional understanding of the modalities of the pathway (section 6).
3. *Twenty-one experiments* (see annex IV). Each CoS PhD researcher negotiated a research agenda with farmers and implemented field experiments based on the outcome.

Data gathering was largely done by the senior author, but the others also had intimate knowledge of CoS design and implementation. Data gathering included the following:

1. *The senior author compared the eight diagnostic studies (Nederlof et al., 2004).*
2. *During the field implementation phase between May and September 2004 and between June and August 2005, she visited each of the eight CoS PhD researchers to identify and understand the different experiments that they conducted with farmers. During these field visits, she conducted several semi-structured interviews with each of the researchers, observed the experiments and*

participated in group discussions of farmers and other stakeholders. This fieldwork led to a database for each experiment.

3. *The researchers each had natural and social science supervisors from Benin or Ghana and from the Netherlands. The senior author discussed some issues with them.*
4. *She analysed the contents of the written material produced by the CoS PhD researchers about their experiments and research procedures.*
5. *The eight researchers were given the opportunity to check the database with information on their experiments. A disadvantage of this approach was that the researchers could interpret the data differently, or deny information provided by other stakeholders. The advantage was that the approach was completely transparent.*
6. *Finally, the senior author organised brainstorming sessions with the eight researchers to discuss her procedures and outcomes.*

The main informants for the present study were, therefore, the CoS PhD researchers. Even though the senior author visited the research sites and had discussions with farmers, extension workers and supervisors, the phase of the programme at the time of writing (i.e. still in full progress) and the issue of ownership (i.e. research outcomes 'belong' to the researchers) favoured this approach. A shortcoming of the present article is, therefore, that it does not systematically analyse the points of view of all stakeholders involved in each experiment. A further shortcoming is that all authors of the present article are part of the CoS programme and not independent outsiders. This leaves open the possibility of selectivity and bias. Meta-research proved challenging in terms of data collection, ownership, confidentiality and sensitivity.

The pathway of the CoS programme

The present section focuses on the first research question: how did CoS design its pathway? We present the steps taken in chronological order. We do not discuss why Benin and Ghana were selected and how the partnerships in the Programme were established. Hounkonnou *et al.* (2006) provide that information. Looking back, CoS was established on the basis of a rather conventional identification and formulation process that could have benefited a great deal from the kind of bottom-up process suggested and tested by Bunders (1994).

Pre-analytical choices

From the start, CoS was designed on the basis of the idea that innovation is the emergent property of a multi-stakeholder process, and that, in the conditions prevailing in West Africa, research must proceed on the basis of 'listening to the cradle' (Hounkonnou, 2002) and in multiple spaces for learning close to the innovative dynamism of farming communities struggling to maintain livelihoods in adverse conditions. What is more, CoS was to unfold in action with a minimum of pre-analytical choices (Giampietro, 2003) prior to actual field work, so as not to reduce the degrees of freedom for making later choices on the basis of information from field or farmers, and so as not to pre-empt opportunities for replication (Röling *et al.*, 2004). Finally, CoS was to include both natural and social scientists, so as to pay attention to both technical and institutional aspects of innovation.

Of course, a number of pre-analytical choices had to be made, for example with respect to the natural and social sciences that were to be involved (e.g., no animal science and economics), the cash and food crops to be studied, the domains to be covered (IPM, soil fertility and weed management, and plant genetic diversity), and the choice for PhD researchers as the main researchers to be involved.

Technographic studies

CoS' first research step were technographic studies at a macro level to identify opportunities for research to address realistic options. Technography is defined as 'the basic 'field' within which technological interventions take place. It is an attempt to map the actors, processes and client groups in such a way that the analyst can see beyond the technology itself to the problems technological applications are supposed to solve, and to understand what parties and interests are being mobilised in arriving at solutions' (Richards, 2001: 1).

The teams of CoS supervisors who carried out the technographies in Ghana and Benin (while the CoS PhD researchers were undergoing training) opted for case studies of three different cropping systems in diverse agro-ecological conditions. Both teams identified stakeholders in the cropping system concerned and assessed how these perceive its strengths and weaknesses.

The Ghana team described supply chains and explored the strengths and weaknesses of linkages amongst stakeholders of a financial, technological, informational and/or hierarchical nature. The team identified promising innovations within a given cropping system. The Benin team studied innovations that emerged in different cropping systems and the drivers of these innovations (Project COS, 2004). It distinguished between sources of innovation (e.g., public and private organisations, as well as indigenous knowledge) and identified needs for innovation in each cropping system. In hindsight, the design of the technographic studies remains to be better grounded in existing approaches, such as RAAKS (Engel & Salomon, 1997).

Diagnostic studies

As his or her first research activity, each CoS PhD researcher conducted a diagnostic study to identify opportunities, specify the research issues grounded in farmers' needs, identify the villages and research groups with who he/she was to work, and negotiate initial research agendas with local stakeholders, mainly farmers, but including extension workers, researchers and others. These diagnostic studies are empirical studies in their own right that have been published in a special issue of an international refereed journal (NJAS, 2004). The diagnostic studies borrowed from Participatory Rural Appraisal (PRA), Participatory Learning and Action (PLA) and other participatory approaches, including semi-structured interviews with different stakeholders, transect walks, wealth ranking, etc. The two country teams again took slightly different routes.

In Benin, the diagnostic studies were based on experience gained in an earlier cowpea Farmer Field School project (Kossou *et al.*, 2001) and comprised two steps. During the first, villages were selected and researchable topics identified with farmers and relevant stakeholders at the regional level. During the second, more in-depth diagnosis, the researchers set the research agenda with farmers in the villages selected. In Ghana, the researchers zoomed in on one or a few villages, based on recommendations of stakeholders. They did not follow a uniform design and dealt with causes for the problems identified and negotiated possible research interventions and agreements on the roles of the different stakeholders. For further details see Nederlof *et al.* (2004).

Learning groups

Working closely with farmers required the creation of learning groups at the local level. These were composed of farmers, the local extension worker (if present at all), sometimes a representative of a research organisation, and the researcher and his/her assistant. Here also, the two countries proceeded differently. In *Benin*, formalisation of the learning group (i.e. election of at least a president, secretary and organiser) was a prerequisite for engaging in experiments. The attributions of these posts often seemed to result from local politics and sometimes were a reflection of the importance of different ethnic groups, networks, or gender. The researchers from *Ghana* zoomed in on one or few villages, and used the diagnostic study process as a basis for building a learning group. Formalisation of the group took place much later and was the outcome of the co-researching process.

Because of the crop focus of CoS, the first criterion for selecting farmers for the learning group was whether they cultivated "the crop". Some researchers decided to work with existing farmer groups while others deliberately chose to constitute new ones. Members either volunteered or were selected by the community. Participants were likely to be those who could afford to spend some time, labour or material on research, who were relatively better educated, had previous experience with research, and had an established position in the community, i.e. the relatively better off. But the researchers also imposed criteria:

they made sure the groups included resource-poor farmers for whom the CoS effort was intended. The only female researcher (Kudadjie *et al.*, in press) was also the only one who deliberately involved women from the start, even though she also questioned the effect of involving women on the learning process. Both migrant and local farmers had to be involved in the soil fertility studies (Saïdou *et al.*, in press; Adjei-Nsiah *et al.*, in press) and both landowners and caretakers in the studies on cocoa (Dormon *et al.*; and Ayenor *et al.*, both in press). In the case of Saïdou *et al.*, two different learning groups were constituted because the migrants and locals live in separate villages. These groups did however meet occasionally. Vissoh *et al.* (in press) had to establish two groups in each of two hamlets in the same village because of historical frictions.

In all, it seems that different approaches can lead to similar outcomes, in terms of direct impact on the participating farmers. But that does not take into account replication of the learning by members of the farming communities. That issue was not systematically looked at during CoS, with exception of Dormon *et al.* and Ayenor *et al.* (in press) who involved the larger community in the selection and monitoring of the research group. Most other researchers counted on farmers' own channels, such as exchanges with neighbours, relatives and friends. The church played an important role in Ghana and the experiments were discussed either after church meetings or during the sermon when the pastor pleaded with the villagers to understand that the good yields of a fellow villager emerged from research rather than from witchcraft or divine power (Dormon, pers. com. August 2005). Some researchers designed farmer field days to facilitate exchanges amongst participant and non-participant farmers. Some neighbouring villages asked for a similar training through their extension worker. Farmers from the villages Dormon worked in initially trained their neighbours. The institutional space for change identified by e.g., Dormon *et al.*; Saïdou *et al.* and Adjei-Nsiah *et al.* (all in press) potentially would be relevant to a much larger set of farmers than the research groups.

The issue of replication by other farmers is of importance, also given the experience of the farmer field school tradition (van den Berg, 2003) that the complex learning in the experimental groups does not easily 'diffuse', just like one cannot send one child to school and expect its learning to rub off on its siblings. Multiplying the impact from intensive learning beyond the 'diffusion of innovations' in recommendation domains remains a crucial issue. In hindsight, a greater CoS-wide emphasis on the way the research groups were linked to the wider farming community would have been advisable.

Experimenting with farmers

Experimentation represented a mix of laboratory (soil analysis and genetic marking for variety characterisation), on-station (e.g., soil fertility improvement crop practices), and on-farm, with farmers, applied research. None of the issues explored required fundamental research. In some cases, on-the-shelf technologies or ideas could be used, while in others indigenous knowledge was the starting point for developing innovation. Co-research with farmers was conducted in accordance with principles of Participatory Technology Development (PTD) that aim to strengthen local capacities to experiment and innovate.

A key aspect of the CoS experiments was that they were not limited to technology, but very deliberately included experiments with institutional components of innovation, in accordance with innovation as 'a successful combination of hardware (the equipment), software (the idea) and orgware (the embedment), viewed from the societal and/or economic point of view' (Smits, 2000: 10). Leeuwis and van den Ban (2004) explain software in terms of 'new ways of thinking' and 'mindsets'. Orgware concerns both organisational and institutional conditions. A number of times CoS farmers ran into problems when using a technology that the experiments had generated because of institutional constraints. In such cases, the researchers tried to directly deal with those constraints, e.g., through the collective acquisition and/or production of inputs (Dormon *et al.*, in press), through creating agreements among tenants and landowners (e.g., Saïdou *et al.*, in press), or through seeking a marketing outlet (e.g., Kudadjie, *et al.*, in press). Technological solutions thus led to institutional problems that engaged farmers in expanding rounds of innovation (especially Dormon *et al.*, in press).

Variations on the theme by the eight CoS research projects

The analysis of the variations on the CoS theme by the eight researchers respectively focuses on the opportunities identified, on the convergence of social and biological sciences, and on the way the researchers realised the 'mix' of outcomes in Table 1.

Identification of opportunities

Table 2 shows that the CoS process was able to throw up realistic opportunities that could be addressed through agricultural research.

Table 2: Opportunities identified in the eight CoS studies

CoS PhD researcher	Opportunity identified	Source
Samuel Adjei-Nsiah and Aliou Saïdou	Rotation of cereals with cassava for soil fertility improvement; Improved tenure relationships between land owners and migrants can optimize use of land; Heterogeneity of goals pursued in cropping systems generates alternative soil fertility management practices.	Indigenous practice identified by technographic studies; Diagnostic studies show influence of tenure relations on soil fertility and its management. Experimental phase throws up ideas.
Pierre V. Vissoh	Emergence of herbaceous weeds as a result of more permanent land use leads to decline of soil fertility and crop yields. It raises demands on farm labour that forces farmers to reduce farm size. Combining farmer best practices for weed control and science-based practices and new varieties.	Emotional stake (weeding during childhood. Professional experience. Diagnostic and Technographic Studies.
Afio Zannou	Management of genetic diversity of cowpea and yam as a source of resistance to pests and diseases and reduction of post-harvest loss. Consumer preferences for cowpea and yam.	Work with farmers during diagnostic studies. Suggestions by supervisors
Comfort Y. Kudadjie	Importance of sorghum and value of genetic diversity to farmers as a source of adaptation and control. Guinness Brewery requires sorghum for beer brewing.	Diagnostics Studies and farmer observations. Suggestions by supervisors.
Godwin K. Ayenor	Certification of organic cocoa brings premium price. Improved producer price for cocoa. American company willing to buy organic cocoa. Option of mass spraying with Neem. Farmers' indigenous knowledge about use of ants as an enemy of capsids. CRIG-developed pheromone for trapping capsids.	Farmer who travelled abroad and realised that he was growing 'organic' cocoa. Diagnostic studies identified group of keen organic farmers. Involvement of CRIG in supervision.

Emmanuel N.A. Dormon	Improved producer price for cocoa. Existing technologies become worthwhile through combination with social-organisational arrangements. Cheating with scales by Licensed Buying Agents. Possibility of organizing labour and processing arrangements with farmers.	Technographic and Diagnostic Studies. Entrepreneurship. During research process (e.g., continued diagnosis). Negotiations with farmers. On-the-shelf technologies.
Antonio A.C. Sinzogan	Privatisation of cotton chain creates space for improvement of its efficiency. Interest in organic cotton as a potential for Benin. Problems associated with pesticide use (resistance and resurgence of pests).	Cotton farmers who have started 'rival' farmer organisations to resist rent seeking in the chain. Several attempts to start organic cotton production in Benin and Mali.

In some cases, it proved difficult to realise the opportunity identified. In Ayenor's case, the American company that wanted to buy organic cocoa withdrew when COCOBOD proved reluctant to cooperate in organising certification. Sinzogan's case shows that powerful rent seekers reduced the efficiency of the cotton marketing chain, an institutional constraint that could only be exposed through careful field research (see also Mongbo, 2006). The soil fertility researchers were hindered by the fact that farmers could not sell the surpluses they generated because of the limited opportunities for food marketing. Table 2 shows that only few opportunities can be regarded as resulting from supply-driven research.

Convergence of social and biological sciences

The convergence of social and biological sciences within CoS was established at two levels: the researcher and his/her team of supervisors. All researchers engaged in both social studies and agronomy experiments (that will be published elsewhere). All CoS PhD researchers had both biological and social scientists as supervisors. CoS shows that such an inter-disciplinary set-up is possible and effective in generating a wide range of different studies that have been and will be published in a wide range of scientific journals, and, more importantly, that allowed the research efforts to zoom in on farmers' conditions and institutional constraints. Inter-disciplinarity proved directly related to identifying and effectively developing integrated solutions. The 'social construction of weeds' reported by Vissoh *et al.* (in press) clearly shows what happens if 'hard' weed science is not informed by social science and what can be gained by including it.

The intensive intertwining of social and technical aspects emerges in each of the CoS research projects, e.g., with respect to soil fertility management and land tenure; Neem spraying and Neem seed procurement and processing; weed management and labour; sanitation of diseased cocoa pods and labour; organic cocoa production and certification; IPM and cotton supply chain management; and crop genetic diversity management and religion. It is not that technology requires some social and cultural additives to become an innovation; innovation itself is basically multi-dimensional, comprising hardware, software and orgware (Smits, 2000; Leeuwis & van den Ban, 2004).

Combining effectiveness, optimisation and satisfaction in field experimentation

The CoS PhD researchers combined on-station and on-farm, with farmer research; negotiated the trials, tests and experimental designs with the stakeholders involved; and facilitated the interactive multi-stakeholder learning. Two researchers (Saïdou *et al.* and Adjei-Nsiah *et al.*, both in press) could implement the whole research sequence of laboratory, on-station and on-farm research, with farmer, research by using an adapted form of 'mother and baby trials' (Johnson *et al.*, 2003). The mother trials are researcher-designed and conform to requirements for scientific analysis while the baby trials provide a single replicate. This design allows farmers to actively engage in experiments and researchers to understand the technology in the farmers' context.

The others had more trouble in creating the mix of outcomes and had to enter into negotiation with farmers to ensure that both scientific and farmers' criteria were satisfied (cf. Ooi, 1999; van den Berg, 2001). The researchers had to accept a trade-off between criteria that were purely 'scientific' and those that were required for ensuring acceptance by farmers. Dormon *et al.* (in press), for example, found that farmers had already started applying the treatments on control plots because they had seen the benefits of the technologies in the experimentation plots. It proved necessary to substitute the 'contaminated' control plots with plots of farmers who were not part of the program. However, these farmers also became aware of the benefits of the technologies and asked for compensation in order to maintain the controls.

The researchers focused on 'satisfaction' of the resource-poor farmers but also felt the pressure to apply scientific methodological protocols. The academic criteria seemed to become more important than the process as the scientific stakes became more of an issue. Kudadjie (pers. com. June 2005) discussed the issue on whose land they would carry out the experiment. Eventually they settled on using pots (to determine the germination of seeds stored under different conditions), which had the additional advantage that a uniform soil type could be guaranteed. Sinzogan *et al.* (in press) proposed to install the experiments on farmers' fields. They argued that it would be better to have a collective plot instead. Other issues that were negotiated included the size of the plot, the number of treatments and, the number of seeds. In some cases, the researcher had to design discovery learning, such as cage experiments, to facilitate decision-making. Another problem encountered was that farmers tend to make 'intuitive observations', e.g., they observe differences that convince them without using a ruler or other instruments. When evaluating the results, the farmers Kudadjie worked with stated that one more germinated seed could make a difference (whereas this perception would prove wrong when the experiments were statistically analysed).

Applying the Analytical Framework

By establishing multiple learning sites with farmers, and by imposing a minimum of requirements or pre-analytical choices, the pathway designed by CoS allowed for a wide range of experiments that generated a number of the outcomes stipulated in Table 1. It is especially during the diagnostic studies that the demand-driven and client-oriented character of CoS was established and strengthened. They played an important role in 'democratising' the research in that they created opportunities for the intended beneficiaries to influence the research agenda and the issues it was to address. Table 3 is an attempt to systematically assess to what extent the CoS-designed pathway generated the outcomes specified in the analytical framework.

Table 3: Preliminary assessment of outcomes generated by CoS

Outcome	What CoS realised
Opportunity identified	CoS' exploratory and diagnostic devices allowed for a wide range of realistic opportunities to be established for each of the studies, notwithstanding some pre-analytical choices that were inevitably made.
Space for change established	The technographic and diagnostic studies established multiple learning sites around issues relevant for small-scale farmers. Space for deployment of the skill of the researcher was established and shared learning took place.
Explanation and Understanding	Fundamental research was not part of CoS.
Effective solutions	At the time of writing, analysis of the technical outcomes of the experiments was still ongoing. Preliminary results show that at all learning sites technologies were generated that could be shown by scientific criteria to impact significantly on criterion variables (defined together with farmers). Institutional space for change was successfully generated in a number of instances, as reported in the International Journal of Agricultural Sustainability special issue.
Optimisation of local situation	Innovations were identified and tested in local conditions. No inputs were provided or artificial situations created. In some cases, constraining framework conditions were stretched. All experimentation was done with farmers and approved by them.
Satisfaction of local needs and aspirations	The protracted diagnostic phase and the attention paid to relationships with communities, to establishing farmer groups, and to negotiating research topics and agendas created conditions for satisfying local needs and aspirations.
Scaling-up	CoS as a whole could have paid greater attention to involving the larger farmer community in the research process. Institutional scaling up is not addressed in the present study and will be part of a second phase of CoS.

Conclusion

The following answers to the research questions can be given.

- *Question 1: design of a pathway of science. CoS has been able to design a pathway that has been effective in realising some of the outcomes specified as essential for agricultural research to impact on the livelihoods of resource-poor farmers in West Africa (Table 1). In the absence of effective countervailing power by farmers, space was created for demand articulation. The key device was an elaborate process of 'zooming in' on opportunities, constraining framework conditions, suitable research problems, and suitable farmer partners, through technography, diagnostic studies and through extensive interaction with farmers and other stakeholders.*
- *Question 2: identifying opportunity. For a range of cash and food crops, across a range of agro-ecological zones, CoS was able to establish realistic opportunities for improving rural livelihoods. The evidence from CoS is that opportunity can have many drivers, including market changes, and chances for stretching institutional constraints. The CoS experience shows that the focus on supply-driven development of technologies as the only way to generate opportunities is mistaken and counter-productive.*
- *Question 3: converging social and biological science. All researchers applied social science insights. The evidence from CoS is that realising essential outcomes such as identifying opportunity, space for change, optimisation, and satisfaction (Table 1), require social science input.*
- *Question 4: Creating an appropriate mix of outcomes. Although it often required careful negotiation with farmers, all CoS PhD researchers seem to have been able to implement a mix of activities that address the outcomes of Table 1, in the understanding that CoS did not include fundamental research, and can, at the time of writing, not yet adduct proof of having developed effective solutions.*
- *Question 5: prospects for scaling up. The CoS experience has only solved part of the problem. Although it has provided a range of options for replication of the results of intensive learning by other farmers than those directly involved, large-scale multiplier effects still require considerable thought. Perhaps farmer education is the only answer. The institutionalisation of the successful elements of the CoS approach, including diagnostic studies, learning groups, etc., will be the key aspect of the second phase of CoS. A very promising start has been made during the first phase by involving a wide range of key institutional actors in Benin and Ghana in supervision, advisory panels, steering committees, and as members of workshops and seminars (e.g., Van Huis, 2006).*

In all, we feel justified in claiming that CoS has, in a number of diverse contexts and with respect to different crops, demonstrated that it is possible to establish vibrant multi-stakeholder learning coalitions at the local and programme levels that generate enthusiasm and drive and that link researchers' and farmers' interests around realistic opportunities.

We wrap up the conclusion by examining how the pathway established by CoS fits the National Systems of Innovation (NSI) approach that features a switch from research to the processes of innovation (Barnett, 2004). The NSI approach integrates 'supply push' of the research community and 'demand pull' of society, and pays attention to framework conditions, organisational learning, and other issues that are addressed as 'elements of best practice in innovation', but that, perhaps 'as a measure of the dominance of the research community' have not been applied in research work (Barnett, 2004).

Table 4 (Hall *et al.*, 2004) shows that the CoS approach squarely fits into the NSI tradition. CoS represents a detailed and tested approach to NSI that could inform national strategies.

Table 4: Similarities and differences between agricultural research systems and agricultural systems of innovation (Hall *et al.*, 2004: 10).

Institutional Features	Agricultural research	Innovation systems
Guiding agenda	Scientific	Developmental
Relationships involved	Narrow, hierarchical	Diverse, consultative
Partners	Scientists and other public agencies	Various combinations of scientists, entrepreneurs, farmers, development workers and policy actors from the public and private sectors
Selection of partners	Predetermined by institutional roles defined by the arrangement of the research system	Coalitions of interest determined by the nature of task, national institutional context and skills, resources available
Role of partners	Fixed, predetermined by institutional roles defined by the arrangement of the research system	Flexible, determined by the nature of task, national institutional context, and skills and resources available
Research priority setting	Fixed by scientists	Consensual by stakeholders and depending on the needs of different tasks. Technology foresight and technology assessment approach
Work plans and activities	Fixed at the beginning of the project	Flexible, iterative
Mandate for research/task approach adopted	Fixed by institutional norms of the research system	Negotiated through coalitions of interest
Knowledge produced	Technical/scientific	Technical, scientific and institutional

Indicators of performance	In scientific terms to other scientists	In development terms to donors. In terms of fulfilling role in task network to other partners
Responsibility for achieving impact	Other agencies dedicated to extension and technology promotion	Collective capacity of task networks, social capital, partnerships skills
Capacity building	Trained scientists and research infrastructure	Collective capacity of task networks, social capital, partnership skills

Note: This table exaggerates the differences between the two paradigms for illustrative purposes

But a major question has not been answered: how can an approach such as CoS become mainstream and have impact in terms of national food security? Tripp (2006) argues, on the basis of an analysis of three participatory agro-technological projects, that existing methods are at best locally effective. They have promising features but are far from offering generic solutions. In his view, participatory agro-technology development will not become an answer until more attention is paid to institutional dynamics. At the time of writing, this is the major challenge for the CoS follow-up.

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Annex I: Dissertation topics and PhD Researchers of the CoS programme per country and their supervisors

Country	Topic	PhD researcher	NS NL	NS Africa	SS NL	SS Africa
Benin	IPM in cotton	Antonio A.C. Sinzogan	Van Huis	Kossou, Atachi	Jiggins	Voudouhé
Benin	Soil fertility management (e.g., using cassava in rotation, impact of land tenure on fertility management)	Aliou Saïdou	Kuyper	Kossou, Anastaze	Richards	Tossou, Mongbo
Benin	Weed management (Striga in Sorghum, Imperata)	Pierre V. Vissoh	Kuyper	Ahanchedé, Gbehounou	Röling	Agbo, Mongbo, Hounkonnou
Benin	Genetic diversity management (cowpea and yam)	A. Zannou	Struik	Zoundjihekpon, Ahanchede	Richards	Tossou, Voudouhé, Agbo
	Integrated Crop Management and institutional analysis (cocoa)	Emmanuel N.A. Dormon	Van Huis	Obeng-Ofori	Leeuwis	Sakyi-Dawson, Alhasan, Fiadjoe
	Organic Pest and Disease Management (cocoa)	Godwin K. Ayenor	Van Huis	Obeng-Ofori, Padi	Röling	Atengdem
	Soil fertility management (e.g., using cassava in rotation, impact of land tenure on fertility management)	Samuel Adjei-Nsiah	Giller, Kuyper	Cobina, Abekoe	Leeuwis	Sakyi-Dawson
	Genetic diversity management (sorghum), role of sorghum in livelihood strategy	Comfort Y. Kudadjie	Struik	Offei, Atokple	Richards	Atengdem

Source: Own compilation semi-structured interviews
NS= Natural Scientist, SS= Social Scientist, NL= Netherlands

The Convergence of Sciences (CoS) programme has been conducted in Ghana and Benin. Cotonou is Benin's and Accra Ghana's capital. In Benin French is the official language and in Ghana English.

Ghana

In Ghana, the British local government system was introduced in 1859 by the Municipal Ordinance (Anaman, 1999) aimed at creating municipal councils in the coastal towns of Ghana. In 1878, administrative control was transferred to grassroots level for the first time (ibid). Høgvold (1999) states that town councils[47] under colonisation were organised in such a way that:

> *"it was the interests of the British government and the governor that were preserved and not the interests of the people."*

He continues that citizens' possibilities to influence and participate in decision-making were brought to a minimum. In 1951, these town councils were replaced by 252 small councils and a first move was made towards a democratic election system (Anaman, 1999). After independence in 1957, a centralised government system was implemented. The country was re-divided into 59 larger councils. The president at that time, Kwame Nkrumah, reduced the influence of native authorities and other local institutions (ibid). A severe economic crisis dominated Ghanaian life from the 1970s onwards, partly as a result of the failure of agrarian socialism and industrialisation (Eicher, 2003).

In 1983, the Economic Recovery Programme (ERP) was launched[48] to re-organise the political and administrative setting, including measures towards decentralisation (Gerken *et al.*, 2001). In 1988/89 the Provisional National Defence Council (PNDC) government adopted a package of reforms aimed at decentralising Ghana's political and administrative system (Ayee and Tay, 1998). Decentralisation was expected to increase economic growth through improved governance. Firstly, decentralisation of local governance took place. Secondly, decentralisation of ministries occurred. From that time till date, Ghana counts ten administrative regions and one hundred and ten (110) districts.

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47 Local governmental structures during colonisation.

48 After strong recommendations of the World Bank and IMF.

The present decentralised government system is based on a three-tier system: national, regional and district. Gerken *et al.*, (2001: 25) explain that

> *"The central government and the ministries are the leading bodies for policy and programme planning, monitoring and evaluation, while the district assemblies and their district administrations are responsible for implementation of policies and programmes and provisions of services."*

The regional level is responsible for the coordination of the development plans of the districts and the administration of funds from the central government. The regional level is nominated, not elected.

Ayee and Tay (1998) analyse the decentralisation process in Ghana and conclude that some of the powers have been partially moved from the central to the local levels. However, finance and personnel are still completely controlled at the national level. Wunsch (1998) argues that Ghana's decentralisation was merely a modest policy of de-concentration. Ayee and Tay (1998) state that:

> *"Ghana's decentralization programme is a "top-down" one, initiated by the central government, which has transferred some of its power and authority to the district assemblies."*

In 1962, responsibility for agricultural research in Ghana moved from the Ministry of Agriculture (MOFA) to the Council for Scientific and Industrial Research (CSIR). From that time onwards, extension workers could not interact with scientists as easily, except in the case of externally financed projects. In 1991, the World Bank created two separate projects: the National Agricultural Extension Program (NAEP) and the National Agricultural Research Program (NARP), which stressed extension and research as separate entities. In order to create convergence between both projects, in 1994, Research Extension Linkages Committees (RELC)s were established. Members of the RELC are researchers, farmers (mainly award winners of the Farmer's day, which are the 'best' farmers), MOFA staff- including extension workers and district directors, district assemblies and other stakeholders. When, in 1999, the NAEP and NARP projects came to an end, RELC also did not have funds to function anymore and became dysfunctional. The RELCs have recently been revitalized under the Agricultural Sector Services Investment Project (AgSSIP), set up by the Ghanaian government with World Bank support. The zonal RELCs have been abolished and replaced with regional ones in each of the ten regions (CSIR/MOFA, 2002). For the planning of RELC activities district planning sessions are organised, followed by subject matter planning sessions (constituted of two to three districts). Subsequently, regional planning meetings are held. On-farm adaptive research provides the context for collaboration among researchers, extension officers and farmers.

In Ghana, extension is provided by the state (MOFA), parastatal organizations (such as COCOBOD (Ghana Cocoa Board, whose extension functions recently have been transferred to the Ministry), the private sector (cotton and pineapple producers), Non Governmental Organizations (NGOs) (TechnoServe, World Vision, GTZ), and farmer-based organisations (FBOs) and cooperatives.

In Ghana, traditional types of FBOs exist, for example groups that work together in peak labour agricultural production periods. These organisations are often temporary or season-based, and can be referred to as indigenous FBOs. In addition, several FBOs have been created (see also Debrah and Nederlof, 2002). Government initiated co-operatives were first introduced in 1928, in an attempt to improve the quality of cocoa for export. These co-operatives were so successful that by 1960, the co-operatives were marketing about 40% of the entire cocoa crop. In Ghana, co-operatives can be found in almost every economic activity. In general, farmers seem to be rather sceptical about co-operatives, probably because they are initiated by the government and not by farmers themselves. In addition, several NGO's created FBOs. In some cases FBOs are created to facilitate the work of the NGOs, in others to facilitate farmers' access to services and to increase collective action for communal objectives. For several specific commodities, including the coffee, cocoa and sheanut, cotton and rice, producer associations are organized on a higher scale. A national FBO, the Ghana National Association for Farmers and Fishermen (GNAFF) has emerged in 1992, and aims to help farmers and fishermen adapt to changing situations (e.g., input marketing), and to represent farmers' interests vis-à-vis the government in policy making. More recently the Apex Farmers' Organisation of Ghana was created (Dohmen, 2003). Yet, farmer's countervailing power remains limited.

Benin

Between 1960, when Benin gained independence, and 1972, several military regimes governed the country. During this period governmental influence on the political and economical environment was high. From 1972 to 1989, a Marxist-Leninist regime was put in place. From 1989 onwards, a multi-party regime has been installed. Since then Structural Adjustment Programs of the World Bank have been implemented. During this period relations between the rural areas and central power changed and some decision power was shifted from the central government to local authorities. In 1991, actions towards decentralisation began, but it took eight years to complete the legal texts. Decentralisation in Benin is based upon five laws[49], of which the last one[50] (concerning elections at the communal level), was finally agreed upon in March 2000.

To facilitate decentralisation the administrative system was organised at the national, departmental, *sous-prefectorial,* communal and village or town ward level. The departmental level coincides with the former provincial level, and *sous-prefectorial* with the former district level. First, six departments existed, i.e. Atacora, Atlantique, Borgou, Mono, Ouémé and Zou. Nowadays there are twelve, but the former division into six departments is commonly used. Each department has a *prefet* and each *sous-prefecture* a *sous-prefet*; communes are led by a mayor and villages by village chiefs.

Each of the 77 communes elect a '*Conseil Communal*' also called '*Collectivité Local*', the number of members depending on the actual population size of the commune. The '*Conseil Communal*' elects a Mayor amongst them. The elections for the '*Conseil Communal*' will be held at the '*arrondissement*' level. '*Arrondissements*' are a collection of grouped villages. According to Mongbo (2001), these villages are arbitrarily grouped and hardly share any political experience. Each '*Conseil Communal'* is supposed to ensure local development and will acquire financial autonomy. The national state will appoint an administrative secretary to support the '*Conseil Communal*'. Also, the central state administration will be brought closer to local level through the appointment of a Prefect for each of the 12 provinces.

In Benin, FBOs have been created from the colonial epoch onwards (see also Debrah and Nederlof, 2002). These FBOs and cooperatives, called '*Société indigène de prévoyance*' (SIP) and later '*Société mutuelle de production rurale*' (SMPR), existed in addition to the indigenous FBOs. With independence in 1960, new organizations emerged such as the collective plots and the '*cooperative d'aménagement rural*' that still exist. In 1990, the Marxist-Leninist regime ended and with liberalisation farmers were free to organize themselves. Consequently, in the past years numerous organizations emerged and disappeared, which resulted in a rather chaotic situation. In 1991, agricultural government services have been

49 Loi N° 97- 028 du 15 janvier 1999 portant organisation de l'administartion territoriale de la Republique du Bénin, Loi N° 97- 029 du 15 janvier 1999 portant organisation des communes en Republique du Bénin, Loi N° 98-005 du 15 janvier 1999 portant organisation des communes à statut particulier, loi N°98- 007 du 15 janvier 1999 portant régime financier des communes en République du Bénin. (see Loi et décrets sur la décentralisation au Bénin. http://www.pdm-net.org/french/cdr/decentralisation/benin/loi_benin.htm

50 Loi N°98- 006 du 9 mars 2000 portant regime electoral communal et municipal en republique du Bénin.

restructured and the state started its withdrawal from production services for agriculture. For example responsibilities for cotton were transferred from the cotton parastatal and the government-run rural development centres (Centre d'Action Régionale pour le Développement Rurale -CARDER), to the FBOs *Groupement Villageois*, gathered in the *Fédération des Unions de Producteurs du Bénin* (FUPRO). Nowadays many new cotton networks have emerged (Sinzogan, in press). At present, at least twenty national FBOs exist. The Chamber of Agriculture, initiated by the government, recognizes the existence of all the national FBOs and aims to collaborate and function as an umbrella organization. In general, FBOs are recognized to be very influential and play a major role in Benin's decision-making processes.

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Annex III: Background PhD researchers CoS Programme

Specialisation	Educational background	Professional experience	PhD researcher
Social scientists	BSc Agricultural economy (Kumasi) MSc MAKS[1] (WUR)	Agricultural socio-economist	Emmanuel N.A. Dormon
	BSc Crop Science (Legon) Mphil Extension (Legon)	Negligible	Comfort Y. Kudadjie
	Ingenieur Agro-economist (Cotonou) Master environmental science (Cotonou)	Economics and genetics	Afio Zannou
	DEUG Agronomy (Cotonou) Ingenieur Agronome Crop Sciences (Cotonou) MSc Agricultural extension (Nigeria)	Research and extension	Pierre V. Vissoh
Natural scientists	MSc Agronomy (Cuba)	Social and biological consultancy	Godwin K. Ayenor
	BSc Crop Science (Kumasi) MPhil Crop Science (Legon)	Integrated Crop management, Tree crop production (technical)	Samuel Adjei-Nsiah
	Ingenieur Soil science (Cotonou) MSc Soil and Water science (WUR)	Ecology and research	Aliou Saïdou
	Ingenieur Agronomy (Cotonou) MSc Crop Science and IPM (WUR)	Technician, cowpea project	Antonio A.C. Sinzogan

Source: Own compilation semi-structured interviews

1 MAKS stands for Masters in Agricultural Knowledge Systems

Annex IV: CoS PhD researchers, their focus of research experiments and the institutional issues involved.

CoS PhD Researcher	Pre-analytical choice made through TS and DS	Experiments conducted with farmers	Socio/ Institutional issues
Samuel Adjei-Nsiah	Soil fertility management, private and grassroots crops (cassava, cowpea, etc.), Ghana	1. Cassava crop rotation for soil fertility improvement 2. Cowpea crop rotation for soil fertility improvement 3. Evaluating soil fertility improvement strategies	Land tenure arrangements
Aliou Saïdou	Soil fertility management, private and grassroots crops (cassava, cowpea, etc.), Benin	1. Cassava crop rotation for soil fertility improvement 2. Residual effect of cotton fertiliser on maize (cotton-maize rotation)	Land tenure arrangements
Pierre V. Vissoh	Weed management, private and grassroots crops (sorghum, cowpea), Benin	1. Integrated strategy for spear grass management (deep ridging, rotation of cowpea and maize, deeper hoeing and hand pulling of speargrass shoots) 2. Sowing dates to manage Striga gesneriodes 3. Transplantation of sorghum to manage S. hermonthica including intercropping maize-leguminous crops and using trap crops to allow permanent land cropping	Social construction of weeds, the impact of weeds on rural poverty, implications for labour
Afio Zannou	Genetic diversity management, private and grassroots crops (yam, cowpea), Benin	1. Storage methods to improve quality of yam seed 2. Yam fragmentation to improve seed quality 3. Cowpea characterization 4. Yam characterization	Embedding cultural practices in traditions and beliefs
Comfort Y. Kudadjie	Genetic diversity management, private and grassroots crops (sorghum, millet), Ghana	1. Evaluating local sorghum and millet seed storage practices of farmers: lessons for learning and conducting research with farmers 2. Learning with farmers to develop shared perspectives on variation in sorghum	Marketing opportunities through Guinness brewery
Godwin K. Ayenor	Integrated pest management, cash crop (cocoa), Ghana	1. Pheromone traps against capsids 2. Aqueous Neem Extract against capsids 3. Ant colonies as biological agents against capsids	Development of organic marketing chain/ LARC

Antonio A.C. Sinzogan	Integrated pest management, cash crop (cotton), Benin	1. Comparison of different strategies in cotton pest management in Benin (including LEC and organic) 2. Mixture of Botanicals with half the dose of recommended insecticides against cotton bollworms 3. Maize/sorghum/ cowpea-cotton strip intercropping against bollworm	Institutions and stakeholders in the cotton marketing chain
Emmanuel N.A. Dormon	Integrated crop management, cash crop (cocoa), Ghana	1. Integrated Crop Management This concerns re-introduction of the following practices: i. Capsids control using Aqueous Neem Extract ii. Blackpod control using cultural control methods iii.Removal of parasitic and epiphytic plants using existing cultural practices	Neem availability, labour use, economic opportunities, negotiating accuracy of scales with LBC's

Source: Own compilation semi-structured interviews

SUMMARY

The contribution of agricultural research to improving resource-poor farmers' livelihoods has remained sub-optimal. Explanations for this lack of impact are diverse and many approaches were proposed over time to address them, amongst others: transfer of technology to teach farmers the 'right technologies'; designing technological packages (high yielding varieties, fertilisers and pesticides), and facilitating access to input and credit; adapting to farmers' conditions through farming systems research and on-farm research; and participation of farmers in planning and evaluation. All these approaches did however not improve the situation in West Africa as drastically as was hoped for. In the late 1990's, therefore, it was recognised that researchers alone cannot grasp the complexity and dynamics of the local situation and the need arose for researchers to join forces with farmers to explore and design viable innovations. The reason for the failure of agricultural research was sought in the methodology used. Alongside numerous approaches such as the facilitation of learning, Participatory Technology Development and Farmer Field Schools emerged. The Convergence of Sciences (CoS) Programme squarely fits within this movement and builds on the achievements of these approaches. These approaches as well as the background of this study are extensively discussed in chapters 1 and 2 of this dissertation.

We conducted a meta research on the pathway(s) of science that CoS followed. Eight PhD researchers from Ghana and Benin conducted in their respective countries research on integrated pest management, weed management, soil fertility and crop diversity with resource-poor farmers aimed at improving the livelihoods of the farmers. The PhD researchers used a social and biological science perspective and were supervised by supervisors from both the social and biological disciplines, both from West Africa and the Netherlands. The comparison of the field experiences formed the basis of our meta research on the CoS programme. The details of the methodology and the background of the PhD research programmes are explored in chapter 3. Before studying CoS, in order to hone our approach and methodology, and to develop our conceptual framework with respect to the pathways for science, we first looked at two completed research programmes in West Africa which aimed at joining forces with farmers to explore and design viable innovations.

In chapter 4 we discuss a cowpea Farmer Field School project implemented in Northern Ghana. Whereas Farmer Field Schools are conceived to facilitate farmer learning, the researchers involved in the project had other objectives, namely increased adoption of improved cowpea varieties and better pest management practices. As a result, the curriculum was adapted to the researchers' objectives to push techniques and technologies that 'work'.

In this example the method used -Farmer Field School- was transformed into an instrument to transfer technologies. The case studied taught us that an approach, which has been proved successful, can be co-opted for other purposes.

In chapter 5 we studied a project aimed at ameliorating the livelihoods of resource-poor farmers in central Togo through soil fertility improvement. The project engaged in extension activities for diffusion of technologies that 'worked' according to the scientists and experimentation to look at options for as yet unsolved problems. However, the pre-analytical choices made -the unavoidable choices made before engaging in project or research activities- hindered the development of dyadic relationships among farmers and researchers. Farmers were not involved in discussing the pre-analytical choices and as a result the project was not grounded in their needs and expectations. Scientists had a tendency to evaluate a technology based on whether it 'works', while the resource-poor farmers would use many other criteria (with a social, economical or institutional nature), based on what is acceptable to them. The project helped to increase yields and productivity, but did not assist in developing or identifying marketing channels and therefore left the farmers with surpluses they could not sell. The study showed us that it is not enough to develop systems that 'work'. Farm innovation need to be grounded in farmers' needs, be acceptable to them, allow for scaling up and to be embedded in macro-level opportunities.

After studying the two completed projects, we improved the initial conceptual framework (developed in chapters 1 and 2) for an alternative pathway of science in an intermezzo chapter, based on a further analysis of the work of previous PhD researchers (Tekelenburg and van Schoubroeck). The framework proposes seven research functions that science has to address if it intends to improve resource-poor farmers' livelihoods. The functions are expected to generate the following outcomes: explanation and understanding of (causal) relationships, effective solutions to problems, optimisation of the local situation, satisfaction of local needs and aspirations, scaling up, opportunities identified and space for change established.

To improve the impact of agricultural research and develop an alternative pathway of science as a dyadic relationship between farmers and researchers, CoS considered the following principles important:

1. *Democratisation of science through converging scientific and farmers' knowledge.*
2. *Innovation comprising a mix of technical, economical, social, and institutional elements and therefore requiring an effective encounter of social and biological science.*

The CoS pathway(s) of science followed four steps, discussed in chapters 6 and 7:

1. *Pre-analytical choices were made with regard to, for example, the countries in which the studies would be conducted and the scientific disciplines involved. An attempt was made to keep the choices to a minimum, leaving as many degrees of freedom as possible for farmers and researchers to determine their priority needs and research agendas. In hindsight, even more choices could have included farmers' visions in order to enhance the likelihood that research would eventually benefit them. Donor requirements and time and funding constraints hampered such a procedure.*
2. *Technographic Studies were conducted by senior CoS scientists in West Africa to determine promising innovation domains on a macro-level to assure that realistic opportunities within existing framework conditions would be addressed by the PhD researchers. In retrospect, the studies could have delivered more by making other (pre-analytical) choices, e.g., not (exclusively) a crop focus, and tapping from other existing approaches.*
3. *Diagnostic Studies zoomed in on the village level and aimed at grounding the experiments in the needs and opportunities of the farmers. The Diagnostic Studies in Ghana and Benin differed in a number of ways mainly due to experiences with a project previously undertaken and with many of the same stakeholders. It remained important, throughout the whole research sequence, to keep a diagnostic perspective, as the situation in West Africa is very dynamic.*
4. *Experimenting with farmers represented a mix of laboratory, on-station, and on-farm applied research. Co-research accorded with the principles for Participatory Technology Development. The experiments deliberately included a combination of hardware (the technology), software (the idea) and orgware (organisational and institutional arrangements) to constitute viable innovations.*

In chapter 6 we discuss how the CoS PhD researchers from Ghana and Benin, with their different backgrounds, conducted diagnostic studies as a first step of their research aimed at developing technologies together with farmers. Our meta research was conducted in a participatory manner and based on consultations with the researchers. The comparison revealed that diagnostic studies identified and established forums of stakeholders, especially of farmers, who were to play key roles in the co-construction of knowledge during the field experimental phase that followed the diagnostic studies. The diagnostic studies gave farmers a say in the design and conduct of the experimental phase. In addition, the diagnostic studies have led to transparent choices with respect to the selection of sites, farmers and experiments. Furthermore, the conditions for negotiation were created. Finally, the diagnostic studies played a crucial role in making the partners within the Convergence of Sciences programme aware of the importance of contextual framework conditions in determining the relevance of the project.

Chapter 7 is based on the analysis of the work at eight pilot learning sites in the Convergence of Sciences (CoS) programme. Each site featured research for development with resource-poor farmers and other stakeholders. On the basis of literature review, we first built a perspective on the mix of research outcomes that seems necessary for agricultural research to be demand-driven and client-oriented. This perspective then served as the framework for analysis of the work at the learning sites. Adapted and consolidated on the basis of this empirical work, the framework represents a set of preliminary ideas for designing an effective pathway for agricultural science. The analysis shows that CoS has, in a number of diverse contexts and with respect to different crops, demonstrated that it is possible to establish vibrant multi-stakeholder learning coalitions at the local and programme levels. It is further possible to identify promising opportunities that can be effectively addressed by agricultural research, if that research is multi-disciplinary, refrains from making constraining pre-analytical choices, pays attention to institutional aspects, and uses procedures that ensure that research is not only supply, but also demand-driven.

In conclusion, the Convergence of Sciences Programme proposes an alternative pathway of science to enhance the likelihood that resource-poor farmers' livelihoods will improve. However, the PhD researchers had not finalised their analysis at the time of writing of this dissertation and therefore a final verdict of how the research impacted on the livelihoods of the farmers involved remains to be given and also many questions remain unanswered with regard to scaling up and institutionalising such an approach. The dissertation shows, nevertheless, that the preliminary results are promising and that relevant opportunities for farmers can be identified. Of special interest has been the development in the CoS project of an approach that both looks at the technological and institutional components. Not all eight CoS researchers have been equally effective in experimenting with institutional framework conditions. However, the CoS experience shows that it is possible.

RESUMÉ

La contribution de la recherche agricole en ce qui concerne l'amélioration des conditions de vie des petits paysans reste très limitée. De nombreux facteurs concourent à ce faible impact. De nombreuses approches ont été développées pour améliorer la situation. Entre autres: le transfert technologique consistant à apprendre aux petits paysans « la bonne manière »; la conception de paquets technologiques (variétés à haut rendement, engrais et pesticides) et la facilitation pour un meilleur accès aux facteurs de production et au crédit; l'adaptation de la recherche aux conditions des petits paysans à travers la recherche du système agricole et la recherche en milieu paysans; la participation des paysans aux processus de planification et d'évaluation de la recherche. Toutes ces approches n'ont pas permis d'améliorer de manière significative la situation en Afrique de l'ouest. A la fin des années 90, il était unanimement reconnu que les chercheurs ne pouvaient à eux seuls maîtriser la complexité et la dynamique des réalités locales, d'où la nécessité pour les chercheurs de travailler conjointement avec les paysans de manière à explorer et concevoir des innovations viables. La méthodologie utilisée par la recherche agricole a été désigné comme la raison de cet échec. D'où l'émergence de nombreuses approches comme l'apprentissage par la facilitation, le Participatory Technology Development et Farmer Field Schools (écoles paysans), et le Programme Convergence des Sciences (la substance principale de cette étude). Les fondements de cette étude et les autres approches sont discutés de manière extensive au chapitre 1 et 2 de cette dissertation.

Nous avons mené une recherche sur la trajectoire de recherche suivit par Convergence des Sciences (CdS). Huit chercheurs aspirant au titre de docteur (chercheur PhD) venant du Ghana et du Bénin ont mené dans leur pays respectif des études sur les problématiques de la protection intégrée des végétaux, la fertilité des sols et la diversité des cultures adopté par les petits paysans pour améliorer leur condition de vie. Les huit études des chercheurs PhD combinent aussi bien les perspectives sociales que biologiques des sciences. Les chercheurs PhD ont en outre bénéficié de la supervision de chercheurs venant des universités partenaires Ouest Africaines et Néerlandaise, spécialisés dans les disciplines sociales et/ou biologiques. Cette recherche est fondée sur la comparaison des expériences de terrain menées dans le cadre du programme CdS. La méthodologie et la substance des recherches PhD sont discutées au chapitre 3. Avant de commencer notre étude sur CdS, il nous a semblé utile d'analyser deux expériences de recherches mener jusqu'à terme en Afrique de l'ouest, dans l'optique de développer un cadre analytique sur la trajectoire de la recherche agricole et consolider notre approche méthodologique.

Au chapitre 4, nous discutons l'expérience du Projet Farmer Field School, installé dans la partie septentrionale du Ghana. L'objectif de l'approche Farmer Field School étant de faciliter l'apprentissage des paysans, les chercheurs impliqués dans le projet avaient deux

objectifs, améliorer le taux d'adoption des nouvelles variétés de niébé et consolider les pratiques de protection des végétaux. Les programmes de formation ont donc été conçus, pour permettre une meilleure vulgarisation des techniques et technologies « qui ont fait leur preuves ». Dans cet exemple, l'approche « Farmer Field School » a été transformée en outil de transfert de technologie. La leçon principale de cette étude, c'est que « une approches ou innovation qui a démontré suffisamment sont efficacité, peut sous certaines conditions être détournée et être utilisée à d'autre fins. »

Le chapitre 5 porte sur un projet dont l'objectif est d'améliorer les conditions de vie des petits paysans de la partie centrale du Togo, à travers l'amélioration de la fertilité des sols. Le projet c'est engagé dans la vulgarisation des technologies « efficace » du point de vue des scientifiques et des expériences de terrains. Les choix pré analytiques qui ont été opérés (les choix inévitables fait avant de commencer un projet ou une activité de recherche) ont considérablement handicapés le développement de l'interaction paysans-chercheurs. Les paysans n'ont pas été impliqué lors de la discussion sur les choix pré analytiques, ce qui à eut pour conséquence un déphasage entre le projet et les aspirations et besoins des paysans. Les scientifiques ont tendance à évaluer les innovations en fonction de leur efficacité technique, alors que pour les petits paysans d'autres critères (social, économique ou de nature institutionnelle) préside leur évaluation sur les innovations qui leurs sont acceptables. Le projet a permis d'améliorer les rendements et la productivité agricole, ce pendant a faillit en ce qui concerne l'identification et le développement de solutions commerciales. L'étude montre qu'il ne suffit pas de développer des outils efficaces. Les innovations agricoles doivent être développés en tenant compte des besoins et aspirations des paysans de manière à leur être acceptable, de permettre une application plus élargit et être en phase avec les opportunités dans un échelon plus vaste et plus complexe que l'environnement immédiat des paysans.

Après avoir étudié les deux projets, nous avons amélioré le cadre analytique initial (développé au chapitre 1 et 2) dans un chapitre intermezzo, de manière à proposer une alternative à la trajectoire actuelle de la science. Cette analyse approfondie est fondée sur deux thèses de chercheurs PhD (Tekelenburg and van Schoubroeck). Le cadre analytique propose sept fonctions de la recherche que la science doit prendre en compte si elle veut améliorer les conditions de vie des petits paysans. La prise en compte de ces fonctions devrait permettre l'émergence de: l'explication et la compréhension des interactions, solutions adéquats aux problèmes, l'optimisation de la situation local, la satisfaction des besoins et aspirations locales, application à un niveau élargit, identifier les opportunités et définir les possibilités de changement.

Afin d'améliorer l'impact de la recherche agricole et proposer une vrai alternative aux pratiques scientifiques actuelles. Le programme CdS à consideré qu'il est important de réunir les principes suivants :

1. *La démocratisation de la science par la convergence des connaissances des scientifiques et des paysans.*

2. *L'innovation, constituée par un mélange d'élément technique, économique, social et institutionnel, ce qui implique une réelle prise en compte des sciences sociales et biologiques.*

La trajectoire de recherche de CdS se décompose en quatre phases, détaillé au chapitre 6 et 7 :

1. *Les choix pré analytiques ont été faits, par exemple, en fonction des pays dans lesquels ont lieux les études et des disciplines scientifiques impliquées. Il a été décidé de minimiser au temps que faire ce peut les choix pré analytique afin de laisser un plus grand champ de décision aux paysans et aux chercheurs, en ce qui concerne la détermination des objectifs de la recherche et de l'identification des besoins prioritaires. De manière rétrospective, il ne fait aucun qu'une implication plus grande des paysans au moment des choix pré analytiques leur aurait été plus bénéfique. A cause des exigences des bailleurs de fonds et certaines contraintes de temps, il n'a pas été possible d'adopter cette procédure.*

2. *Les études technographiques ont été menées en Afrique de l'ouest par des scientifiques expérimentés du programme CdS, afin de déterminer les possibilités d'innovation au niveau macro, ceci pour s'assurer d'une prise en compte réaliste des opportunités de recherche par les chercheurs PhD. Une analyse rétrospective, montre que les études auraient gagnés en efficacités si d'autres choix (pré analytique) avaient été faits, par exemple par la non concentration (exclusive) sur certaines filières agricoles, et en s'inspirant des travaux déjà existants dans le domaine.*

3. *Les études diagnostiques portent une attention particulière sur le niveau village, elles font coïncider les expérimentations scientifiques avec les besoins et possibilités des paysans. Les études diagnostiques menées au Ghana et au Bénin présentent un certain nombre de différences dues à la diversité des expériences des projets et des acteurs impliqués. Puisque les réalités ne sont pas les mêmes dans le temps et partout en Afrique de l'ouest, il est important de garder à l'esprit que l'aspect diagnostique, reste le fils conducteur durant l'intégralité de la recherche.*

4. *La phase d'expérimentation avec les paysans, représente un mélange de recherche en laboratoire, en milieu clos (station de recherche), et en milieu ouvert (champs des paysans). La recherche en coopération avec les paysans suit les principes de Participatory Technology Development. Pour constituer des innovations efficaces, les expérimentations doivent délibérément combiner le « hardware » (la technique), le « software » (les idées), et le « orgware » (la réalité organisationnelle et institutionnelle).*

Au chapitre 6, nous discutons comment les chercheurs PhD du Ghana et du Bénin, venant d'horizon différents, ont conduit les études diagnostiques, c'est à dire la première phase de leur recherche qui consiste, en collaboration avec les paysans à développer des technologies. Nous avons conduit notre recherche de manière participative, basé sur une étroite collaboration avec les chercheurs PhD. Par comparaison il ressort que les études diagnostiques ont permis d'identifier et de mettre en place des forums de discussion pour les acteurs, plus particulièrement pour les paysans impliqués dans la construction des connaissances durant la phase expérimentales qui à suivit les études diagnostiques. Les études diagnostiques ont permis aux paysans d'exprimer leurs préoccupations lors de la confection et de l'exécution de la phase expérimentale. Les études diagnostiques ont aussi apportés une plus grande transparence dans les choix, en ce qui concerne la sélection des sites, des paysans et des types des essais. Elles ont en outre crée les conditions pour une meilleure négociation. Finalement, les études diagnostiques ont permis de sensibiliser les différents acteurs du programme Convergence des Sciences sur l'importance du cadre contextuel dans la définition des priorités du projet.

Le chapitre 7 s'appuie sur l'analyse des huit sites pilotes d'apprentissages du programme Convergence des Sciences. Chacun des sites concerne le développement de la recherche avec les petits paysans et d'autres acteurs. Sur la base d'une recherche documentaire, nous avons identifié les éléments importants pour formulé un cadre combinant les résultats de la recherche agricole de manière à ce qu'elle soit suscitée par une demande réelle sur le terrain, et qu'elle prenne en considération les exigences des demandeurs. Cette perspective à ensuite servit comme cadre d'analyse des études menées sur les sites d'apprentissages. Adapté et consolidé sur la base de ce travail empirique, le cadre d'analyse doit être considéré comme un essai empirique de concevoir un protocole efficace de la recherche agricole. L'analyse démontre que, CdS a su, dans différents contextes et sur plusieurs cultures agricoles, faire la preuve qu'il est possible de mettre en place au niveau local et au niveau programme, une coalition active d'apprentissage avec plusieurs acteurs. Il ressort entre autre, qu'il est possible d'identifier les questions auxquelles la recherche agricole peut trouver des réponses efficaces. A condition que la recherche soit multidisciplinaires, s'abstienne autant que faire se peut d'opérer des choix pré analytiques contraignants, porte une attention particulière aux aspects institutionnels, et utilise des procédures qui permettent de s'assurer que la recherche n'émane pas seulement du fournisseur, mais est aussi la conséquence d'une demande exprimée.

En conclusion le programme Convergence des Sciences, propose une alternative à la trajectoire habituelle de la recherche, afin de renforcer les chances que la recherche agricole contribue significativement à l'amélioration des conditions de vie des petits paysans. Les chercheurs PhD n'ayant pas finalisés leurs différentes études au moment de la rédaction de cette dissertation, il est prématuré de donner un verdict concernant l'impact du programme de recherche CdS sur les conditions de vie des paysans. D'autres questions notamment sur l'application des technologies à une échelle plus grande et la question de l'institutionnalisation de l'approche reste sans réponse. Ce pendant les résultats préliminaires de l'étude démontre que la trajectoire de recherche suivi par CdS est prometteur et que de pertinentes opportunités pour les paysans peuvent être identifié si l'on prend en considération aussi bien les aspects technologiques et institutionnels. En dépit du fait que seulement une partie des chercheurs ont conduit des expériences qui tiennent compte effectivement des conditions du cadre institutionnel, l'étude démontre qu'il est possible de le faire.

SAMENVATTING

De bijdrage van onderzoek aan het verbeteren van de levensomstandigheden van kleine boeren in West Afrika is tot op heden zeer beperkt. Verklaringen voor dit gebrek aan effect zijn uiteenlopend. In de loop der tijd zijn dan ook verscheidene benaderingen ontstaan om aan deze beperkingen tegemoet te komen, onder andere: overdracht van technologie om boeren 'de beste technologie' te leren; aanbieden van technologische pakketten (hoge opbrengst variëteiten, kunstmest en pesticiden) en het vergemakkelijken van toegang tot inputs en krediet; aanpassing aan de omstandigheden van boeren d.m.v. 'systeemonderzoek' en onderzoek op de boerderij en deelname van boeren in planning en evaluatie. Al deze benaderingen hebben de situatie in West Afrika echter niet zo drastisch verbeterd als werd gehoopt. Eind jaren negentig werd dan ook erkend dat onderzoekers alleen de complexiteit en dynamiek van de lokale situatie niet kunnen omvatten en werd ingezien dat onderzoekers beter direct met boeren kunnen samenwerken om innovaties te verkennen en ontwerpen. De reden voor het falen van onderzoek werd dan ook gezocht in de gebruikte methodologie. Naast benaderingen als *facilitation of learning, Participatory Technology Development* en *Farmer Field Schools (FFS)* ontstond het *Convergence of Sciences* (CoS) Programma. Deze benaderingen alsook de achtergrond van dit vraagstuk worden uitgebreid in hoofdstukken 1 en 2 besproken.

We hebben een 'Meta-onderzoek' uitgevoerd naar de 'onderzoekstrajecten' die CoS heeft gevolgd. Acht doctorale CoS onderzoekers uit Ghana en Benin hebben in hun respectievelijke landen samen met boeren onderzoek gedaan naar geïntegreerd pestbeheer, onkruidbeheer, bodemvruchtbaarheid en gewasdiversiteit ten einde de levensomstandigheden van deze boeren te verbeteren. Deze doctorale onderzoekers hebben een natuur- en sociaalwetenschappelijk perspectief gebruikt en worden door begeleiders uit beide disciplines en vanuit West Afrika en Nederland terzijde gestaan. De vergelijking van de veldervaringen vormt de basis van ons Meta-onderzoek naar het CoS programma. De details van de methodologie en de achtergrond van de acht PhD onderzoeken staan beschreven in hoofdstuk 3. Voordat we echter CoS bespreken, om onze benadering en methodologie te verankeren en ons analytisch kader te verfijnen, hebben we eerst twee casus bestudeerd van afgeronde onderzoeksprojecten in West Afrika, welke als doel hadden samen met boeren levensvatbare innovaties te identificeren en ontwerpen.

In hoofdstuk 4 bespreken we een cowpea FFS project in Noord-Ghana. FFS zijn bedoeld om het leren van boeren te faciliteren, echter, de onderzoekers die bij het project betrokken waren hadden andere doelen, zoals toenemende adoptie van verbeterde variëteiten en een betere beoefening van pestbeheer. Het resultaat hiervan was dat het curriculum voor de FFS werd aangepast aan de doelen van de onderzoekers, zodanig dat technieken en technologieën die technisch gezien werkte werden gepromoot. In dit voorbeeld werd de gebruikte methode -de FFS- getransformeerd in een instrument om technologieën over te dragen. De onderzochte casus leert ons dat een benadering die succesvol is gebleken, misbruikt kan worden voor andere doelen.

In het vijfde hoofdstuk bestuderen we een project wat gericht is op het verbeteren van de levensomstandigheden van kleine boeren in centraal Togo door het verbeteren van de bodemvruchtbaarheid. Het project richtte zich op (1) voorlichtingsactiviteiten voor de diffusie van technologieën die volgens onderzoekers werken en (2) experimenteren voor het bekijken van opties voor tot op heden onopgeloste problemen. Echter de preanalytische keuzes -de onvermijdelijke keuzes die gemaakt worden voor dat een project of onderzoeksactiviteit aanvangt- belemmerde de ontwikkeling van gelijkwaardige relaties tussen boeren en onderzoekers. Boeren werden niet betrokken in het maken van preanalytische keuzes en als gevolg daarvan was het project niet afgestemd op hun behoeften en verwachtingen. Onderzoekers hadden de neiging technologieën te beoordelen op de mate waarin deze 'werken', de kleine boeren daarentegen hanteerden een breed scala aan argumenten (van sociale, economische en institutionele aard) gebaseerd op wat zij acceptabel vinden. Het project heeft er mede toe geleidt dat opbrengst en productiviteit verbeterde, maar hielp niet met de ontwikkeling of identificatie van marktkanalen en lieten daardoor de boeren achter met een overschot dat zij niet konden verkopen. De studie toont dan ook aan dat het niet genoeg is om een systeem te ontwikkelen dat werkt. Boeren innovatie moet verankert zijn in hun behoeften, acceptabel, geschikt voor het toepassen op grotere schaal en ingebed in kansen op een macro-economisch niveau.

Na het bestuderen van twee afgeronde projecten hebben we het (in hoofdstuk 1 en 2 ontwikkelde) kader voor een alternatief onderzoekstraject verbeterd gebaseerd op een nadere analyse van het werk van twee eerdere doctorale studies (Tekelenburg and van Schoubroeck). Dit kader, wat beschreven wordt in een intermezzo hoofdstuk, stelt zeven onderzoeksfuncties voor, die onderzoek moet aankaarten als het doel is boeren levensomstandigheden te verbeteren. De functies worden geacht tot de volgende uitkomsten te leiden: uitleg en begrip van (oorzakelijke) relaties, effectieve oplossingen voor problemen, optimisatie van de lokale situatie, bevrediging van lokale behoeften en aspiraties, toepassing op grotere schaal, kansen geïdentificeerd en ruimte tot veranderingen gecreëerd. Voor het verbeteren van de impact van landbouwkundig onderzoek en het ontwikkelen van een alternatief onderzoekstraject als een gelijkwaardige relatie tussen boeren en onderzoekers, werden binnen CoS de volgende principes nagestreefd:

1. *Democratisering van onderzoek door het samenbrengen van wetenschappelijke en boeren kennis.*
2. *Innovatie bestaat uit een mix van technische economische, sociale en institutionele elementen en vereist als zodanig een goede confrontatie van sociale en natuurwetenschappelijke inzichten.*

Het onderzoekstraject van CoS heeft vier stappen gevolgd, welke worden besproken in hoofdstuk 6 en 7:

1. *Preanalytische keuzes met betrekking tot, bijvoorbeeld, de landen waar de studies plaatsvonden en de wetenschappelijke disciplines die erbij betrokken werden. Er werd naar gestreefd deze keuzes tot een minimum te bepreken zodat zo veel mogelijk ruimte werd gegeven aan boeren en doctorale onderzoekers om hun prioriteiten en onderzoeksagenda invulling te geven.*

2. *Technografische studies werden uitgevoerd door senior CoS onderzoekers in West Afrika om veelbelovende innovatie domeinen te identificeren om de kansen te vergroten dat realistische kansen binnen de contextcondities behandeld zouden worden door de doctorale onderzoekers. Terugkijkend zouden de studies meer opgeleverd kunnen hebben als zij andere (preanalytische) keuzes hadden gemaakt, bijvoorbeeld niet (alleen) een gewas focus en voortbouwen op bestaande methoden.*

3. *Diagnostische studies welke inzoomde op dorpsniveau en ertoe diende de onderzoeksactiviteiten in de behoeften en kansen van boeren te verankeren. De diagnostische studies in Ghana en Benin verschilde op een aantal manieren vooral als gevolg van ervaringen met een eerder project. Tijdens het hele onderzoekstraject bleef het belangrijk een diagnostisch perspectief te behouden omdat de situatie in West Afrika zeer dynamisch is.*

4. *Experimenteren met boeren door een mix van laboratorium onderzoek, onderzoek op het proefstation en toegepast onderzoek op de boerderij. Dit gezamenlijk onderzoek voldeed aan de principes van Participatory Technology Development. De experimenten omvatte bewust een combinatie van hardware (de technologie), software (het idee) en orgware (organisatorische en institutionele afspraken) om zodoende tot levensvatbare innovaties te komen.*

In hoofdstuk 6 bespreken we hoe de acht doctorale onderzoekers met hun verschillende achtergronden diagnostische studies uitvoerde als een eerste stap van hun onderzoek wat bedoeld is om technologieën te ontwikkelen met boeren. Ons Meta-onderzoek is uitgevoerd op een participatieve manier en als zodanig gebaseerd op uitwisselingen met de onderzoekers. De vergelijking bracht aan het licht dat de diagnostische studies er in geslaagd waren om fora van belanghebbenden (vooral boeren) te identificeren en opzetten, zodat deze sleutel rollen konden spelen in de gezamenlijke constructie van kennis tijdens de experimentele fase die de diagnostische studie opvolgde. Door de diagnostische studies kregen boeren inbreng in het ontwerp en de uitvoering van de uitvoerende onderzoeksfase. Ook hebben de diagnostische studies geleidt tot transparantie in de keuzes met betrekking tot de plaats, de boeren en de experimenten zelf. Verder speelde de diagnostische studies een cruciale rol om de actoren binnen het CoS programma het belang van de contextcondities voor het bepalen van de relevantie van het project in te laten zien.

Hoofdstuk 7 is gebaseerd op een analyse van de veld activiteiten van de acht studies binnen het CoS programma. Iedere studie kenmerkte zich door onderzoek voor ontwikkeling met kleine boeren en andere belanghebbenden. Op basis van literatuuronderzoek hebben we eerst inzicht ontwikkeld in de mix van onderzoeksuitkomsten welke nodig leken voor vraaggestuurd en klantgericht landbouwkundig onderzoek. Dit inzicht vormde het perspectief van waaruit wij de veldactiviteiten analyseerde. Aangepast en geconsolideerd op basis van empirisch onderzoek bestaat dit kader uit een aantal voorlopige ideeën voor het ontwerpen van een doeltreffend onderzoekstraject. De analyse toont aan dat het mogelijk *is leerallianties van verschillende belanghebbende groepen op verschillende niveaus te* ontwikkelen, in verschillende omstandigheden en voor verschillende gewassen. Verder is het mogelijk kansen te identificeren die door landbouwkundig onderzoek benut kunnen worden als zulk onderzoek multidisciplinair is, zich afzijdig houdt van het maken van beperkende preanalytische keuzes, aandacht besteedt aan de institutionele aspecten, en procedures gebruikt die er voor zorgen dat onderzoek niet alleen aanbod maar ook vraag geleidt is.

In conclusie, het Convergence of Sciences Programma stelt een alternatief onderzoektraject voor, teneinde de aannemelijkheid dat dit onderzoek de levensomstandigheden van arme boeren verbeterd, te vergroten. Echter, de acht doctorale onderzoekers waren nog niet klaar met hun analyse op het moment dat dit proefschrift werd geschreven. Als gevolg daarvan kan een eindanalyse van hoe het onderzoek uiteindelijk het leven van de betrokken boeren beïnvloed en vele vragen met betrekking tot toepassing op hoger niveau en institutionalisering van zulk een benadering nog niet worden gemaakt. Desalniettemin toont dit proefschrift aan dat de voorlopige resultaten veelbelovend zijn en dat relevante kansen voor boeren geïdentificeerd kunnen worden. Speciaal van belang was het ontwikkelen van een benadering die beide technologische en institutionele componenten omvat. Niet alle doctorale onderzoekers zijn even doeltreffend geweest in het experimenteren met institutionele context condities. Echter, CoS heeft aangetoond dat het wel degelijk mogelijk is.

PERSONAL HISTORY

Suzanne Nederlof, born in 1974 in Brandwijk (the Netherlands), studied Cultural Anthropology at the State University of Utrecht after completing high school. After a year, she switched to Wageningen University and Research Centre (WUR) and graduated in Rural Development Sociology in September 1997. During her study she focused on relations between herdsmen and farmers and specialised in communication and innovation studies. She did a case study on platform thinking and collective action.

After her study she worked for 18 months as a research fellow in sociology at the Antenne Sahélienne research project in Burkina Faso, an outreach station of WUR, and focused on social aspects of land use planning. The following two years she worked at the International Center for Soil Fertility and Agricultural Development (IFDC) in Togo, through the young professionals program of the Dutch government. Her task was to empower national farmer organisations.

To learn more about innovative and effective research processes and methods she joined the Convergence of Sciences (CoS) programme initially as an Associate Professional Officer (APO) based at the Food and Agriculture Organization (FAO) of the United Nations in Ghana, later as a PhD candidate (through a competitive grant from the Netherlands Organisation for Scientific Research (NWO). At the final stage of her PhD she started working as an Advisor for farmer-based organisations and rural innovation at the Royal Tropical Institute (KIT), where she is presently employed.

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THE CONVERGENCE OF SCIENCES PROGRAMME

Background

This thesis is the outcome of a project within the programme "Convergence of Sciences: inclusive technology innovation processes for better integrated crop and soil management" (CoS). This programme takes off from the observation that West African farmers derive sub-optimal benefit from formal agricultural science. One important reason for the limited contribution of science to poverty alleviation is the conventional, often tacit, linear perspective on the role of science in innovation, i.e. that scientists first discover or reveal objectively true knowledge, applied scientists transform it into the best technical means to increase productivity and resource efficiency, extension then delivers these technical means to the 'ultimate users', and farmers adopt and diffuse the 'innovations'.

In order to find more efficient and effective models for agricultural technology development the CoS programme analysed participatory innovation processes. Efficient and effective are defined in terms of the inclusion of stakeholders in the research project, and of situating the research in the context of the needs and the opportunities of farmers. In this way stakeholders become the owners of the research process. Innovation is considered the emergent property of an interaction among different stakeholders in agricultural development. Depending on the situation, stakeholders might be village women engaged in a local experiment, but they might also comprise stakeholders such as researchers, farmers, (agri)-businessmen and local government agents.

To make science more beneficial for the rural poor, the CoS programme believes that convergence is needed in three dimensions: between natural and social scientists, between societal stakeholders (including farmers), and between institutions. Assumptions made by CoS are that for research to make an impact in sub-Saharan Africa: most farmers have very small windows of opportunities, farmers are innovative, indigenous knowledge is important, there is a high pressure on natural resources, the market for selling surplus is limited, farmers have little political clout, government preys on farmers for revenue, and-institutional and policy support is lacking. To allow '*ex-ante* impact assessment' and ensure that agricultural research is designed to suit the opportunities, conditions and preferences of resource-poor farmers, CoS pioneered a new context-method-outcome configuration[1] using methods of technography and diagnostic studies.

1 See R. Pawson and N. Tilley, 1997. *Realistic evaluation*. London: Sage Publications.

Technographic and diagnostic studies

The technographic studies explored the innovation landscape for six major crops. They were carried out by mixed teams of Beninese and Ghanaian PhD supervisors. The studies looked at the technological histories, markets, institutions, framework conditions, configurations of stakeholders, and other background factors. The main objective of these studies was to try and grasp the context for innovation in the countries in question, including appreciation of limiting as well as enabling factors.

The diagnostic studies were carried out by PhD students from Benin and Ghana. They focused in on groups of farmers in chosen localities, in response to the innovation opportunities defined during the technographic studies. The diagnostic studies tried to identify the type of agricultural research - targeting mechanisms - that would be needed to ensure that outcomes would be grounded in the opportunities and needs of these farmers. Firstly, that not only meant that research needed to be technically sound, but also that its outcomes would work in the context of the small farmers, taking into account issues such as the market, input provision, and transport availability. Secondly, the outcomes also needed to be appropriate in the context of local farming systems determined by issues such as land tenure, labour availability, and gender. Thirdly, farmers also need to be potentially interested in the outcomes taking into account their perceived opportunities, livelihood strategies, cultural inclinations, etc.

The diagnostic studies led to the CoS researchers facilitating communities of practice of farmers, researchers, scientists from national research institutes, local administrators and local chiefs. The research was designed and conducted with farmer members of the local research groups. Their active involvement led to experiments being added, adapted or revised. It also made the researchers aware of the context in which the research was conducted. A full account of the diagnostic studies can be found in a special issue of NJAS[2].

Experimental work with farmers

After completing the diagnostic studies, the PhD students engaged in experiments with farmers on integrated pest and weed management, soil fertility, and crop genetic diversity, in each case also taking into account the institutional constraints to livelihoods. They focused on both experimental content and the design of agricultural research for development relevance. Experiments were designed and conducted together with groups of farmers, and

2 Struik, P.C., and J.F. Wienk (Eds.), 2005. Diagnostic studies: a research phase in the Convergence of Sciences programme. Wageningen Journal of Life Sciences (NJAS), 52 (3/4): 209-448.

involving all stakeholders relevant for the study. The aim was to focus on actual mechanisms of material transformation – control of pests, enhancement of soil fertility, buffering of seed systems – of direct relevance to poverty alleviation among poor or excluded farming groups. The ninth PhD student carried out comparative 'research on research' in order to formulate an interactive framework for agricultural science.

Project organization

All students were supervised by both natural and social scientists from the Netherlands and their home countries. In each country, the national coordinator was assisted by a working group from the various institutions that implemented the programme. A project steering committee of directors of the most relevant research and development organizations advised the programme. The CoS programme had a Scientific Coordination Committee of three persons, including the international coordinator from Wageningen University.

CoS had two main donors: the Interdisciplinary Research and Education Fund (INREF) of the Wageningen University in the Netherlands and the Directorate General for International Cooperation (DGIS), Ministry of Foreign Affairs of the Netherlands. Other sponsors were the FAO Global IPM Facility (FAO/GIF), the Netherlands Organization for Scientific Research (NWO), the Wageningen Graduate School Production Ecology and Resource Conservation (PE&RC), the Technical Centre for Agricultural and Rural Cooperation (CTA or ACP-EU), and the Netherlands organization for international cooperation in higher education (NUFFIC). The total funds available to the project were about 2.2 million.

TRAINING PLAN CERES

Completed training and supervision programme
Engeline Suzanne Nederlof

Description	Department/Institute	year	credits (ECTS)
I. Orientation			
Preparation CERES PhD proposal	Wageningen University, Wageningen, The Netherlands	2001	8
Presentation research proposal	Convergence of Sciences, seminar, Wageningen, The Netherlands	2001	1
Presentation research proposal	Convergence of Sciences, Planning and Orientation workshop, Cotonou, Benin	2002	1
Preparation NWO PhD proposal (to complement funding)	Wageningen University, Wageningen, The Netherlands	2003	4
II. Research Methods and Techniques			
Training on Facilitation Skills	Management for Development Foundation (MDF) and Bureau Frank Little, Ede, The Netherlands	2000	1
International Training Program on Agricultural Input marketing	International fertilizer development Center Co-sponsored by the Ministry of Food& Agriculture, Government of Ghana. Accra, Ghana	2001	1
Workshop on Techno-graphic Studies	Convergence of Sciences, Accra, Ghana	2001	1
Initiation workshop Technographic studies	Convergence of Sciences, Ghana project team, Accra, Ghana	2002	1
Workshop on Participatory Tools for Agricultural Research and Development	Bonsu Cocoa College, Bonsu, Ghana	2002	1
Workshop on Diagnostic Studies	Convergence of Sciences, Accra, Ghana	2002	1
Training on 'Multi Stakeholder Processes'	International Agricultural Centre, Wageningen, The Netherlands	2004	1

III Seminar Presentations			
Discussing Techno-graphic studies, Diagnostic exploration and the way forward	Convergence of Sciences, workshop, Cotonou, Benin	2003	2
A step towards identifying opportunities for innovation: Experiences and first lessons on the use of Technographic Studies in Ghana	Ghana Science Association, 23rd Biennial Conference, Kumasi, Ghana	2003	2
Research on Agricultural research	Convergence of Sciences, Intercountry meeting, Accra, Ghana	2003	1
Progress of work	Convergence of Sciences, Intercountry meeting, Cotonou, Benin	2004	2
Research on Agricultural research	Convergence of Sciences, Regional Workshop, Accra, Ghana	2004	1
Research on Agricultural research	Faculty of Agriculture, Seminar presentation series, University of Ghana, Legon, Ghana	2004	1
Research on agricultural research: Comparing experiments with farmers	Convergence of Sciences, International conference, Elmina, Ghana	2005	2
IV Academic skills			
Scientific writing (English)	Talencentrum, Wageningen University, Wageningen, The Netherlands	2005	1
French course	Language centre, Bobo-Dioulasso, Burkina Faso	1996	2
Total			**35**