Linking science and farmers' innovative capacity: diagnostic studies from Ghana and Benin

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Abstract

The article is an introduction to a series of articles about diagnostic studies carried out by eight PhD students in Ghana and Benin. These studies form a prelude to their experimental action research with groups of farmers to develop technologies that work in local conditions and are acceptable to farmers. A last article reports on a comparison of these eight studies by the ninth PhD student in the Convergence of Sciences (CoS) project. In this introductory article, it is argued that the need to ground agricultural research in the needs and circumstances of farmers is as strong as the need to ground research in the international scientific discourse. It explores the reasons why the West African context requires careful diagnostic studies to be able to design agricultural research that is of any use. It introduces pre-analytical choice as an overriding concept to explain why choices that reduce the degrees of freedom have to be made explicitly on the basis of criteria. Such criteria are suggested for the quality of pre-analytical choices, and the paper ends by examining the way the CoS project made some of its choices.

Additional keywords: pre-analytic choices, diagnostic study, technographic study, agricultural innovation

> *The approach to the problems of farming must be made from the field, not from the laboratory. The discovery of things that matter is three-quarters of the battle. In this the observant farmer or labourer, who have spent their lives in close contact with Nature, can be of the greatest help to the investigator.*
> *Sir Albert Howard (1943), p. 221*

Positioning the article

Diagnostic studies can take many forms. They include rapid rural appraisals (RRA), participatory rural appraisals (PRA), '*sondeos*', the various forms of farming systems research that have been carried out for at least 40 years (e.g. Collinson, 2000), and the early steps in the Interactive Bottom Up approach pioneered by Bunders (e.g. Broerse *et al.*, 1995). The history of Dutch development assistance to West Africa is replete with efforts to assist the rural poor based on RRA, PRA, Participatory Technology Development, etc., often with little lasting effect. Why yet another attempt?

Several reasons can be given. In the first place, experience with the Integrated Pest Management (IPM) Farmer Field Schools (FFS) in Asia has provided evidence that FFS can make a difference in terms of building farmer competencies and empowerment (e.g. Eveleens *et al.*, in press). The history of the Convergence of Sciences (CoS) project is grounded in the FFS experience, and has been informed by the question how agricultural research could be built into processes of collaborative learning in FFS. In Benin, experience with the Dutch-funded Cowpea IPM FFS project also feeds directly into the CoS project, while Ghana, through the FAO Headquarters located in its capital, has played a pioneering role in introducing IPM FFS into Africa (e.g. Bruin & Meerman, 2001).

In the second place, a number of recent PhD theses presented at Wageningen University have given new insight into ways of deliberately anchoring agricultural research in the needs and conditions of small farmers. We shall come back to some of these below. In the third place, CoS as research on agricultural research, is creating close institutional links with academia in both the South and the North, and seeks to have an institutional impact. Finally, the Guest Editors of this special issue – who together represent some 120 years of experience with efforts to make research 'work' for small-scale farmers – are of the opinion that the material presented in the articles of this special issue is so rich and surprising that it merits publication and comparative analysis.

The present article begins with a diagnostic study as an example of what we are talking about. It then contrasts the context of farming in West Africa with the industrial-country context in an attempt to expose some of the implicit choices that are often made with respect to agricultural research in West Africa. The notion of 'pre-analytic choices' is introduced as a concept that provides a theoretical handle for analysing the research experiences involved in the process of conducting diagnostic studies. The quality of pre-analytic choices is determined by criteria for development-relevant agricultural research. We attempt to specify a number of them. The article concludes with some further background to the diagnostic studies in Ghana and Benin and highlights some of the choices that were made before the diagnostic studies started.

The diagnostic study: an example from Bhutan

In 1993, a young entomologist with an MSc diploma burning in his pocket was sent to Bhutan as a Dutch volunteer to help farmers in this beautiful Buddhist mountainous

country. When he arrived and wondered what to do, he was told to focus on stem borers in maize. After all, every farmer in the country grows maize and stem borers are major pests. But our young man hesitated. He was aware that the choices he was about to make would have enormous implications for what he would have produced after four years of work. He did not want his work only to be scientifically sound, he also wanted to make a contribution to development. At the time, Bhutan had very few entomologists of its own, and our man was keenly aware that his time and energy were scarce goods that needed to be deployed with care. In the end, he spent a year exploring what would be the most useful thing for him to do. His work during that year became one of the most interesting chapters in the PhD thesis he later wrote about the whole experience (Van Schoubroeck, 1999).

His painstaking exploration revealed first of all that farmers were not interested in stem borers. They grew maize as a subsistence crop because prices were too low to grow it for cash, and most farmers also grew small surpluses to brew alcohol. Farmers had no interest in controlling stem borers. But his exploration also revealed that farmers made substantial amounts of ready cash by selling mandarins across the border with India. Unfortunately, exploitation of this virtually unlimited market was seriously constrained by massive premature fruit drop that reduced the quantity that could be sold, in some years by as much as 75%, but seldom by less than a third. It took little time for our entomologist to discover that the fruit drop was caused by an infestation of maggots of the Chinese citrus fly *(Bactrocera minax)*. After discussions with farmers, government officials, traders and colleagues, Van Schoubroeck decided to devote his energy to research on this fly.

Part of the PhD study was spent in the laboratory looking at pest-host plant interactions, at how the citrus fly avoids host plant resistance, at the process of fruit colonization, at oviposition and fruit damage, at proteinaceous food baiting options, and so on. In fact, the laboratory work would have been sufficient to earn Van Schoubroeck a PhD in entomology.

But he was not satisfied. It was all too obvious to him that the knowledge he had gained through the laboratory work was not sufficient for farmers to control the pest in the field. This observation was made more salient by the fact that effective control had to involve an entire village. It is of no use to an individual farmer to control the pest if his neighbours do not also do so. So Van Schoubroeck undertook participatory experimental research to develop effective control measures at the village level together with farmers in two villages, and then tried to scale up the pilot study to other villages. The report on that work takes up the major part of his thesis. It corresponds to the experimental fieldwork that students of the CoS project are carrying out together with farmers. We do not dwell on it here. Particularly relevant for this special issue is the work Van Schoubroeck did before he finally settled on the experimental development work with farmers, i.e., the way he made his choices with respect to the research problem, the kind of process he used to engage with farmers, and the emphasis he put on developing things that work at the village level and that are acceptable to farmers. We could say that Van Schoubroeck carried out a CoS diagnostic study avant la lettre.

The Bhutan case makes clear a few important points:

1. It can be argued that anchoring research in the needs and opportunities of farmers is as important as it is to anchor the research in the international scientific literature.
2. This anchoring in the opportunities and needs of farmers takes time and special effort. Even then Van Schoubroeck did not succeed in scaling up the success in two villages to other villages through the extension service. Apparently, co-learning in action research cannot be replaced by the transfer of knowledge by extension workers, an experience that is consistent with the failure to introduce integrated pest management through conventional extension.
3. Very little effort and few resources are usually devoted to anchoring research in the needs and opportunities of farmers. Diagnostic research still is not standard practice in agricultural research methodology, although *sondeo* techniques, Farming Systems Research, PRA, PLAR, RAAKS, Proto-type Development, etc., have been around for decades. Their methodologies have been developed, tested and applied throughout the world, including West Africa (e.g. Reijntjes *et al.*, 1992; Hamilton, 1995; Pretty *et al.*, 1995; Vereijken, 1995; Engel & Salomon, 1997; Collinson, 2000; Defoer, 2002; Van Paassen, 2004).
4. Cross-checking the problem perception with stakeholders, especially with farmers, helps to focus scarce resources on useful and relevant activities.
5. The process of making deliberate choices to ensure the relevance of agricultural research to small-scale farmers has received relatively little attention. In the conventional model such choices are self-evident, and they are made by scientists and commercial managers. The conventional model can make some lucky strikes. The Green Revolution found a silver bullet for 'doing the easy things' (Castillo, 1998), but since then silver bullets have been few and far between. Today, ensuring that research outcomes 'work' under local conditions and are considered desirable by local people is a *conditio sine qua non*, i.e., without such a process, developing technology for small farmers in impoverished conditions seems a forlorn exercise. To make inroads into the recalcitrant complexity of low external input farming in the highly diverse, rainfall-dependent and risk-prone areas that cover most of the developing world (Chambers & Ghildyal, 1985), the effort of making deliberate choices before engaging in actual experimental work is no superfluous luxury.

Numerous experimental and empirical studies have convinced us that West African farmers would be able to considerably expand their production with their *existing* technologies if the right conditions could be created at higher scales (Hounkonnou, 2001). In other words, more efficient technologies developed through research investment may not be the limiting factor. It may be more important to develop the marketing, service and input delivery and financial institutions in order to provide small farmers with realistic opportunities. In the absence of such institutional development, one can question the extent to which one can or should adapt technology to impossible and unfair conditions. Having said that, we feel that the opportunities forgone by conventional research practices leave considerable scope for improving the outcomes of agricultural research for small-scale farmers. But we concede that choosing research as an entry point into agricultural development is a choice that merits discussion in its own right.

Exploring the rationale for diagnostic studies in West Africa

However poor and miserable some West African farmers might be, all have *veto power* when it comes to accepting the results of agricultural research, i.e., autonomous farmers cannot be forced to adopt technologies. Even the managers of the Soviet collective farms of old were interested in diffusion of innovation research because much to their chagrin the workers in the Sovkhoses and Kolkhozes could be made to accept but not necessarily to use, let alone maintain farm machinery. It proves very hard to get this 'veto power' on the retinas of agricultural researchers and research institutes – despite the massive evidence of non-adoption of their own outputs.

A case study of recalcitrance

A typical example (Nederlof & Dangbégnon (in preparation)) is provided by an important and highly regarded international agricultural research agency in West Africa. On the basis of excellent scientific research, this agency came to the conclusion that improving soil fertility in West Africa is a question of soil organic matter first and nutrients second. Its research showed that planting velvet bean (*Mucuna* sp.) and ploughing under its luxurious growth is the most efficient way to increase soil organic matter. This conclusion drew considerable criticism. After all, *Mucuna* has been 'introduced' time and again. Invariably farmers complain that one cannot eat the beans, that it is hard and painful to incorporate the vegetative matter into the soil and that the bean occupies the land for two seasons during which food production is impossible. Nowhere in West Africa has *Mucuna* been taken up on a large scale as a green manure. Undaunted, the representative of the agency proclaimed that this was not his, but the farmers' problem and that if they wanted to escape from the vicious circle of land degradation and poverty they should plant *Mucuna*. As a scientist he knew what worked, acceptability by farmers was not his problem.

Under his leadership, a major participatory research project was subsequently set up. Using a methodology that featured all the PRA tools and tricks of the trade, farmers were asked to prioritize their constraints. The researchers then divided the farmers' priorities into those for which 'ready technologies' were available and those for which further research was required. One of the priorities was soil fertility decline. The readily available technology? *Mucuna*, of course! But the evaluation of the pilot project to introduce *Mucuna* once again showed, surprise, surprise, that farmers complain that one cannot eat *Mucuna*, that the vegetative matter is hard to incorporate into the soil, and so forth. Agricultural research can be effective only *through* farmers. If it is to have a development impact, agricultural technology development must pay attention to what one would call marketing research in the case of commercial product development, i.e., to the analysis of markets and of consumers' needs. There is no reason why the production of (international) public goods could be effective without marketing research.

The innovativeness of African farmers

The lack of impact of agricultural research in West Africa certainly cannot be blamed on lack of innovativeness on the part of the farmers. West African farmers can be considered among the most innovative in the world. Their indigenous systems represent sustainable, resilient and intelligent forms of agricultural production systems that have supported expanding communities over the centuries (e.g. Mazzucato & Niemeyer, 2000). West African farmers have adopted, adapted and bred maize, *Phaseolus* beans, cassava, tomato and many of the other current staple crops that originated from Latin America and were introduced in fairly recent historical times. One of the authors remembers in 1964 visiting Nigerian villages where cassava, and especially the fermentation techniques required to remove its cyanogenic content, had been introduced only recently when pressure on the land made yam (*Dioscorea* spp.) production less feasible. On the whole, West African farmers have coped with a very rapid population increase over the last 20 years, as well as with adapting their farming systems to deal with new problems such as soil fertility decline, declining rainfall and weed emergence (Vissoh *et al.*, 2004). It is not farmers' *innovative capacities* that are at issue here, but the structural conditions within which farming takes place. Gold Coast tribesmen of old made cocoa Ghana's major export crop without any government assistance, a development that came to a halt only when rapacious politicians and corrupt businessmen killed the goose that laid the golden eggs.

Our favourite example of West African farmer innovativeness is the development, by farmers on the Adja Plateau in Benin of a new farming system based on an oil palm fallow. The system is an answer to extremely high population pressure, 'comatose' soils, and the weed *Imperata cylindrica,* and shows that it is profitable to apply thanks to the production of *Sodabi,* an alcoholic drink distilled from palm wine harvested when the palm fallow is cut down (Brouwers, 1993). In short, our position is that one cannot blame stagnant agricultural productivity in West Africa on the traditionalism or conservatism of farmers. Hounkonnou (2001), who for 12 years surveyed the West African development scene from the vantage point of an international civil servant, has come to the conclusion that the only thing that 'works' in rural West Africa is 'local dynamics', the continuous innovative struggle of local men and women to improve their lives.

Why it has been so difficult to link farmer innovativeness and agricultural research

The question then is why has it not been possible for agricultural research to link up to this rich load of innovativeness. We believe it is too easy here to blame the disciplinary myopia of some researchers and the linear transfer of technology paradigms that international and national science and technology institutions have been following, however serious these impediments are (Kline & Rosenberg, 1986; Chambers & Jiggins, 1987a, b).

Below we explore three factors that could explain why the innovativeness of African farmers has not led to a take-off of agriculture: (1) farmers' lack of countervailing

power in the formal political system, (2) the lack of markets and service- delivery institutions at the middle level, and (3) the systematic creaming off by pre- and post-independence governments of the wealth generated by West African agriculture. It is instructive that some decades ago De Janvry & Dethier (1985) listed the following factors in a CGIAR publication: (1) farmers have no political clout; (2) taxing the beneficiaries of research; (3) lack of co-ordination between technological and economic policies; and (4) little ex-ante analysis and participatory research.

Farmers' lack of countervailing power in the formal political system

Without going into too much detail concerning the arguments and evidence, we accept that most observers would agree that the demise of colonialism left West African countries with a vacuum in terms of checks and balances so that corruption, political adventurism, and exploitation of the powerless could have free play. This picture is striking for what is missing: the absence of structures, processes, and mechanisms for the exercise of countervailing power by organized farmers. Farmers have little control over commodity prices, input providers, government commodity purchase schemes and marketing boards, policies to import cheap foodstuffs that undercut local farmers, and so forth. If one compares this situation with industrial countries, the contrast is sharp.

In most industrial countries, the power of farmers is disproportionate to their numbers, but reflects the fact that they collectively own most of the country's land. The farmers are well organized, and their representatives can be found in the capillaries of the political system. In fact, in many industrial countries farmers are so powerful that they are able to override or modify concerns for health (e.g. food safety), environmental pollution, nature protection, sound water management, tourism, animal welfare, and even prudent economic practice, at the same time receiving enormous subsidies. Farmers in industrial countries have a well-organized institutional influence on decisions about agricultural research and extension, and they are embedded in networks of service-delivery organizations, many of which they own themselves through their co-operatives. Farmers in industrial countries are perfectly capable of telling researchers what they need, and of blocking or subverting the implementation of policies that they do not find digestible.

Based on the experience in industrialized countries, one could say that the fastest way to develop West African agriculture is not to strengthen what in Francophone countries are called *'les organismes d'intervention'*, but farmers' countervailing power *vis-à-vis* those *'organismes'* (Röling & Jiggins, 1998).

Until quite recently there was little chance that such advice would be heeded in West Africa. Colonial governments had no interest in farmers' countervailing power. Heaven forbid! They were good at creating the incentive structures required for small-scale farmers to produce the raw products required by their industries. The introduction of taxes on huts put the pressure on the need to generate cash. And 'cash crops' such as cotton and cocoa were the only ones that could generate it. Carefully designed 'supervised credit' systems that integrated credit, produce buying, input delivery, and farmer payment (after deducting credit repayment and interest) allowed the effective mobilization of the energy of millions of small farmers across West Africa.

Post-independence governments had every reason to maintain this mechanism. But in order for this to succeed, farmers needed to remain non-organized, ignorant of the percentages that governments were creaming off export prices, and powerless to defend themselves against official corruption. Today the situation is changing. Commodity prices have nose-dived. Low prices have made farmers neglect their plantations and crops so that productivity has remained very low, starving governments of revenue. Cotton production in Benin is a good example.

Present West African governments are waking up to the need to provide farmers with a better deal. A good example is the new price policy for cocoa in Ghana (Ayenor *et al.*, 2004; Dormon *et al.*, 2004). But effective farmer countervailing power over the decisions that affect their lives is still a long way off. As far as agricultural research is concerned, diagnostic studies, the way they are conducted in the CoS project, i.e., with full participation of farmers, can for the time being perhaps fill the gap, as this special issue argues.

Lack of markets and service institutions

Industrial agriculture, benefiting from years of investment in research and productivity enhancement, is now able to export food grains, meat and dairy products to West African countries at prices that are a disincentive for West African farmers (Bairoch, 1997). For Kenya, maize can now be imported at prices that are 20% lower than the cost price of the most efficient local farmers. Obviously, there is little reason for the Kenyan Agricultural Research Institute to invest in maize research in this situation (C. Ndiritu, personal communication). In West Africa, examples abound of donor schemes, such as Sassakawa 2000, that successfully create the conditions for small-scale farmers to produce 7 tons of maize per hectare, only to find that farmers do not adopt the required practices because they cannot sell the surplus (e.g. Nederlof & Dangbégnon, in preparation).

If there is one thing that strikes those who have been acquainted with rural development in West Africa, it is the slow development of the institutions at the middle level, such as transparent marketing institutions, dependable veterinary health services, affordable credit provision, competitive input delivery mechanisms, accessible extension services, and produce transport. The only dependable institution in the West African rural scene is the market trader with her sense for business and entrepreneurship. Without her, food delivery to the growing cities would be all but impossible. Recently imposed structural adjustment policies have largely gutted whatever public service delivery mechanisms were available. From an economic point of view, this was perhaps the right thing to do; given the low productivity in monetary terms of West African agriculture, investment in service delivery simply does not pay under existing conditions. But the fact remains that the absence of a network of service institutions in which agriculture is embedded, severely constrains agricultural development. Time and again, pilot projects are set up that artificially create the conditions for a rapid productivity growth. Then, when it comes to scaling up their impressive effects from the pilot level, and to replicate the project on a larger scale through existing institutions, the effects collapse. The existing institutions are simply incapable of creating the conditions in which West African farmers can apply their innovativeness to the benefit

of the public cause. In the absence of a decent monetary income, farmers rationally focus on subsistence production and local marketing and are 'organic by default' (Ayenor *et al.*, 2004). Small wonder that those who measure agricultural development against the growth of productivity per hectare or financial gains are not impressed by West Africa's innovative performance (Chema *et al.*, 2003). They see only stagnation where there is, in fact, a highly dynamic, innovative and adaptive performance in adverse and rapidly changing circumstances.

In all, one can conclude that it has not been possible so far, to set in motion in most of West Africa the agricultural treadmill (Cochrane, 1958; Röling, 2003) by which innovation is propelled by the market, to the benefit of consumers and the competitive position of the country's agriculture. Meanwhile, the world trade agreements have incorporated West African agriculture into a global treadmill in which it does not stand a chance. West African agriculture runs the risk of remaining a neglected and under-valued productive resource that the market disqualifies from making a contribution to world food production.

The situation described has important implications for agricultural research. It is wrong to assume that the goals of technology development are known and can be described simplistically in terms such as 'productivity increase'. Productivity of what? Of men's *and* women's labour? Of land, maybe? Of root crops, or of the so-called orphan grains and indigenous vegetables? It is irrelevant to develop technologies that increase productivity but that can be adopted only as long as special conditions can be created through small-scale projects.

And this brings us to a second good reason to engage in diagnostic studies in West Africa: the opportunities for small-scale farmers to improve upon the intelligent ways they are farming and that at present are very small and vulnerable. It takes considerable skill and effort to identify these opportunities. In a way then, diagnostic studies are ways of ensuring, *ex ante*, that the innovations fostered by the research effort can be scaled up. They do not, of course, ensure that they will be.

Creaming-off farmers' wealth

Industrial countries cream off farmers' wealth and exploit their energy through the treadmill mechanism mentioned above. Technological innovation allows some farmers to be more efficient than the majority. This allows them to capture a windfall profit. However, soon the others start using the technology (the diffusion of innovations process; see Rogers, 1995) and the increased across-the-board efficiency begins to drive down prices, to the benefit of consumers, service organizations and exporters. When the price decreases, farmers who have not changed see their incomes drop and are compelled to innovate. So the price mechanism propels innovation. Farmers who cannot keep up, drop out. Agriculture as a whole becomes more efficient, farm incomes remain low and farmers' profit margins are constantly squeezed. An important and interesting observation is that farmers' countervailing power does not work in the case of the treadmill mechanism because the farming community is not homogeneous. Influential farmers are the ones who have most influence over policy and opportunity; they grab the windfall profits; they benefit from the same treadmill that forces others out of business. In no European country have farmers ever protested

against the fact that the treadmill annually leads to a 2–3% decrease in the number of farmers. The influential farmers buy the land of the dropouts and benefit again.

In West Africa, the capture of agricultural surplus has taken another route. At the time of independence the vast majority of the population was engaged in agriculture. A key source of the wealth generated at the time was the revenue from export crops. The new governments had little option but to exploit the wealth generated by agriculture, but they chose to divert much of the wealth into avenues that created opportunities for a small elite, at the expense of everyone else. The consequences may be described in terms of run-down export industries, low yields per hectare in food production, and, according to some, severe mining of the nutrient reserves of West African soils without replenishment (Smaling *et al.*, 1997). The extent to which soil mining actually occurs is the subject of an interesting controversy (see Mazzucato & Niemeyer (2000) for a study that supports the opposite). The studies of Adjei-Nsiah *et al.* (2004) and Saïdou *et al.* (2004) explore the low external input practices that farmers have developed to counteract falling soil fertility under continuous cultivation when fertilizers are not affordable.

Recently things have begun to improve. Urban development creates markets for locally produced food that cannot be imported cheaply, such as cassava and various vegetables. Farmers increasingly have access to alternative sources of income (e.g. through urban wage employment and emigration) and they no longer have to accept quietly whatever monetary return some public authority offers for an export crop. Governments are forced to offer farmers better deals. In other words, new opportunities seem to be emerging, but these are by no means automatic or obvious.

Diagnostic studies are essential to increase the chances that agricultural research allows farmers to (1) benefit from niches where they can escape from relentless exploitation by governments and companies, (2) reduce their dependence on crops and products that are creamed off, and (3) countervail some of the worst exploitation.

Conclusion

Our survey of the West African context shows that the formulation of the goals of agricultural research is determined by the economic and institutional context. In a situation where farmers do not have political clout, it is all too easy for researchers – explicitly including African researchers educated in the 'Western tradition' – to set goals for research that are based on the implicit values and characteristics of an industrial-country context. Examine, for instance, the tacit assumption that agricultural research serves productivity increase in terms of tons per hectare. One scheme after the other has sought to achieve this, as illustrated by a recent IFAD-supported 'all-out' effort in Ghana to push cassava production. In Benin, the example is a government campaign to get the 'taximoto drivers' (motorcycle taxi drivers) back to the land to grow cassava. The predictable result was flooding of the fresh root and flour markets, a rapid fall in prices, yet another wrong prediction of the internal rate of return of a project, and disillusioned farmers.

As our (superficial) review of the context in West Africa shows, opportunities for farmers in West Africa do not have to be oriented to the mass-market. Varietal

improvement to meet local end users' needs, reduction of labour time for instance for weeding, development of small scale value-adding activities (e.g. improving the distillation of *sodabi* or processing of a locally preferred snack food), and low external input pest management practices, are all examples of farm innovation that is relatively independent from mass market opportunity. Another example would be the development of farming systems that cover farmers' subsistence needs but leave them enough time to gain an income from off-farm work.

In going for 'non-treadmill goals', and by carefully exploring the local windows of opportunity, agricultural research can make a stronger contribution. Diagnostic studies allow the identification of opportunities for innovation that farmers value and that are feasible in the economic and institutional context, even if they are not seen through the 'paradigmatic veil' (T.W. Kuyper, personal communication) that covers the eyes of many international and national experts. Hence our case for urging the desirability of making explicit the pre-analytic choices with which researchers start their research and development work. What was that saying again? 'To assume is to make an *ass* out of *u* and *me*' (J. Ascroft, personal communication).

Pre-analytical choices

Giampietro (2003) defines *pre-analytical choice* as the "choice of relevant goals, variables, and explanatory dynamics for the selection of an explanatory model". An example given by Giampietro (2003) is Mandelbrot's claim that it is not possible to define the length of the coastline of Britain without first defining the scale of the map that is to be used for the calculation. The more detailed the map, the longer will be the same segment of coast. In other words, the pre-analytical choice of the scale will have a major impact on the outcome of the study. Yet the choice of scale is arbitrary. This means that stakeholders intent on knowing the length of Britain's coastline must agree on the meaning of the concept 'length of coast line' and on the scale of the map they will use. Non-equivalent perceptions need to be negotiated because "Different observers can make different pre-analytical choices about how they define 'a segment of coast' which will make them work with different identities for the system to be investigated" (Giampietro, 2003). De Janvry & Dethier (1985) speak of *ex-ante analysis and participatory research.*

> "It is evident that very little information and analysis goes into the definition of research priorities. The result is that the socially more vocal and powerful sectors unduly dominate the course of technological change. Needed to counteract this tendency is a greater collaboration between natural and social scientists, and a greater participation of research beneficiaries (and affected sectors) in the definition of research priorities".

For us, pre-analytical choice is an intriguing concept that gives more theoretical grip on the notion of diagnostic studies. We examine it in depth in the following paragraphs.

Pre-analytical choices are inescapable

In the first place, we note that making pre-analytical choices is a necessary aspect of all research. There is no way researchers can avoid them. One has to ask for funds on the basis of proposals that are not informed by deep understanding of the situation in which, and the beneficiaries for whom one will carry out the research. Researchers choose a specialization according to their interests, talents and opportunities. The choices made by a research institute are determined by its mandate and its donors. And so on. So a considerable number of unavoidable choices are made before the research actually starts.

It is important to realize that such choices *ex ante* reduce one's degrees of freedom to determine research priorities, objectives, problem, subject, scale, analytical framework, variables and beneficiaries of research and development. The notion of pre-analytical choice draws attention to the need to make explicit especially the *irrevocable* choices that are made before embarking upon a research project. In the situation we are addressing, we propose that the most effective way to make such choices is to negotiate the options with the beneficiaries of the research and with the other stakeholders involved in the project. That is, we subject the choice-making process to farmer influence. So the design of the *research processes* comes into question. One of the interesting issues that arise is how this methodological demand interfaces with the conventional demands of experimental research.

Pre-analytical and analytical choices

In the second place, one can ask what are analytical choices in comparison with pre-analytical ones? Can one clearly separate the pre-analytical from the analytical phase? When does the analytical phase begin? Isn't a diagnostic study also a form of analysis? In fact, the very word pre-analytical seems to suggest something value-laden, unscientific, and a label one does not want to have stuck on one's work. We suggest the following distinction in research phases to clarify the issue.

Pre-analytical research phase

During the pre-analytical research phase, all the choices laid down in the formulation of the proposal are being made. It is proposed that explicit recognition is given to the non-scientific justifications that might well include perceptions of the public or self-interest, convenience, contingency, or complacency. Of course, these choices also include the disciplinary perspectives adopted by the research; the research problem, purpose and questions, and any formally stated hypotheses; a conceptual framework and relevant variables; a methodology and research process design, including a unit of observation and a unit of analysis; and the extent to which participatory approaches will be applied. The amount of time and money available is assessed, budgets drawn up, and financial management arrangements made.

The analytical research phase

The research proposal has been approved. It leaves some degrees of freedom for adap-

tation, but the spirit in which it was approved must be honoured scrupulously. The research is implemented according to plan.

Comparison

A clear distinction can now be made between analytical and pre-analytical choices. Pre-analytical choices are the ones made in the first phase. Apart from permitted adaptations to the original plan, the analytical choices in the second phase are about details of research execution within the choices already agreed. The distinction between the two phases draws attention to the importance of the pre-analytical choices. The choices made in the pre-analytical phase fundamentally affect the extent to which the research can benefit a given category of beneficiaries. The technographic and diagnostic studies used in the CoS project can be seen as deliberate efforts to make explicit the pre-analytical choices that are coherent with field realities.

And this raises an issue. Are not the technographic studies and the diagnostic studies analytical efforts to themselves? Isn't the distinction between the two analytical phases a highly artificial one, comparable to the much-maligned distinction between the project formulation and implementation phases in international development practice? The evidence is persuasive that setting in stone the design of a project during the pre-analytical phase on the basis of insufficient or pre-conceived understanding, though convenient from the point of view of the donor and research organization, dooms projects to failure because they cannot be adapted to improved understanding and/or changing framework conditions. Such a *blueprint* approach remains dominant in conventional agricultural research practice, despite the evidence that favours a *process* approach allowing a project to become a joint learning one between the intervening agencies and intended beneficiaries (Sweet & Weisel, 1979). By introducing technographic and diagnostic studies, the CoS project implicitly embraces a process approach.

Diagnostic research as a continuous concern

Has the CoS project entered a pre-configured 'implementation phase' now that the diagnostic studies have been done, i.e., having begun in process, is it sliding into a conventional blueprint mode of execution? As the diagnostic studies reported in this special issue show, it appears to be impossible to make that statement. In the dynamic conditions in which the CoS researchers are operating, their efforts to contextualize and stabilize their research 'once and for all' are continually subverted. The cotton scene is changing very rapidly (Sinzogan *et al.*, 2004), farmers' perceptions of plant genetic traits are greatly affected by the nature of the season (Kudadjie *et al.*, 2004; Zannou *et al.*, 2004) and the prospects for the marketing of (organic) cocoa are undergoing a complete transformation (Ayenor *et al.*, 2004; Dormon *et al.*, 2004). Our conclusion is that one needs to continue to maintain a *diagnostic perspective* throughout the research project and be prepared to adapt the project accordingly and to the extent it is (still) possible, probably especially in the more specific and concrete aspects. This means that the design of the project is best conceived as a dynamic process that allows the greatest flexibility and ability to adapt. Any choice that severely reduces the degrees of freedom required for adaptation needs very careful consideration.

Who make pre-analytical choices?

Not only agronomists make pre-analytic choices. Social scientists are equally capable of making them. Take the notion of a 'farmer'. The very word suggests that we are dealing with a fellow in overalls and boots who is a full-time professional farmer, intent on capturing every opportunity in agriculture that becomes available. He has a wife at home who cooks the food, looks after the children, grows some vegetables for the relish, keeps up the networks, and humours the farmer when the prices go down yet again. So the concepts of farmer and farm family, inherited from current industrial agricultural scenarios, can easily put one off course from the start. The same goes for words like farm, youth, entrepreneur and ploughing.

Similarly, farmers make pre-analytical choices even if they are often quite tacit. An example is documented by a seasoned NGO worker who went to do the research for his Masters in Mozambique (Levine, 1996). His subject was intriguing. After the civil war, the farmers who had been refugees in Congo, Tanzania, Zimbabwe and so on, returned home and resumed farming. Would they have changed their farming as a result of exposure to other practices? The fieldwork suggested at first that it was a preposterous idea. All farmers who were interviewed claimed they were still farming as their fathers and mothers had taught them. It was only when Levine began to look at, and talked to farmers about concrete practices, that the *de facto* influence of the refugee period became apparent. This example shows that farmers can also find it hard to talk about their farming and their reasons for making choices.

Types of pre-analytical choices

Both scientists and farmers can make choices based on lack of knowledge. They may not understand the complex life cycle of a pest, the role played by natural enemies, or the contribution of mycorrhiza. As partners in a research project, farmers and other stakeholders also make choices that can strongly affect the outcome of the project. A very important choice they make is the decision whether or not a research project has the potential to make a real contribution and whether the people introducing it are serious and trustworthy. With respect to this choice, many farmers and other stakeholders have learned that the only possible benefits from research projects are the immediate ones, the payments, inputs, and handouts, and not the long-term benefits promised by the researchers.

Finally, also the politicians, the traditional leaders and officials involved in a study may make pre-analytical choices that are heavily biased by previous experiences. Such experiences may make them suggest that this project will yet again lead nowhere so that they might as well go for the maximum direct benefit one can get out of it, in terms of vehicles, computers and so forth. In other words, an agricultural research project is like a joint venture. It is essential that the 'business partners' involved get to know each other well enough to engage in the shared actions out of which trust emerges.

Conclusion

Given all the traps that can steer research off course before it has even begun, how do we know when we have done it right? Can we assess what pre-analytical choices had what effects on the course and the outcome of a research project? Can we objectively judge the quality of a diagnostic study that seeks to explicate the pre-analytic choices in negotiation among stakeholders? We remarked earlier that, at the time of writing this introduction, the researchers are still working on their field experiments so that we cannot judge the quality of the diagnostic studies from the point of view of outcomes. However, some preliminary observations are made in the concluding article (Nederlof *et al.*, 2004) on the consequences of the diagnostic studies for the course the various research activities are taking. Below we develop some criteria for assessing the quality of the choices made.

Preliminary criteria for assessing the quality of choices

The questions that need to be answered

Tekelenburg (2002) worked for eight years in Cochabamba, Bolivia, in a development project that sought to regenerate degraded mountain farmlands in the High Andes using the cactus pear for human, cattle and cochineal feed and for re-planting the barren slopes. Out of this experience he drew conclusions for the types of 'agricultural research' that were required for a development project that is effective in supporting the rural poor. This study allows us to place diagnostic studies in the wider framework of a design for pro-poor research. Tekelenburg suggests that the following fundamental questions must *all* be answered to achieve 'development' outcomes:

1. *What useful abiotic and biotic relationships can be constructed*? For such questions Tekelenburg had to go right back to fundamental research, for example, for understanding the life cycle of a new pest.
2. *What can technically make a difference*? A great deal of applied experimentation and conventional agricultural research, grounded in international scientific work, had to be carried out for this purpose. What pheromones can be used to lure the males of the insect into traps? What natural enemies can be used to control the pest? The general question is: what are the best available technical means for given (i.e., assumed) human problems? Most agricultural research falls into this category.
3. *What can work in the context*? Answering this question requires an analysis of the context in which small-scale farmers live. This is usually achieved by paying attention to the agro-ecological zone. But equally important is the analysis of the market, input provision, transport availability, and risks of theft. As we have seen, it is no use to carry out research on maize productivity in Kenya if you can import maize 20% cheaper than can be produced with the best local technology;
4. *What can work in the farming system*? Here, farmers' labour availability, gender differences, knowledge, access to land and other resources, land tenure, market opportunities, etc., determine the range of appropriate options. At this point, one

has to leave the disciplinary or sectoral perspective altogether and focus on how the outcomes of the research fit into the local system. Will it work within that system? It is the fundamental question of the Farming Systems approach.

5. *What will be acceptable*? What systems do farmers want and need, given their explicit enthusiasms, alternatives, cultural inclinations, experience, livelihood strategies and superior insight into local conditions and constraints? To answer this question, and avoid invoking farmers' veto power, one has to leave behind any pretence that the scientist alone can determine what is best. The question cannot be answered without engaging farmers as co-researchers and without empowering them to have clout over the research process.
6. *How can the outcomes be scaled up*? Most research projects can be considered expensive, small-scale, pilot efforts that become socially effective only if the experiments are replicated at a societal scale, for example in factories or in markets. In this respect, the work of Latour (1999) on Ferdinand Jolliot who worked to ensure that atomic energy became part of France's policy programme is a classic study of scaling up. Scaling up is not only a question of doing more of the same, i.e., through the diffusion of a given technology among farmers, but especially a question of change in institutional relationships in marketing chains, consumption patterns, education, government budgets, etc.

It is important to realize that *all* these questions need to be answered. It is also important to realize that these questions cannot be answered as a linear sequence or checklist that is finalized at the close of the diagnostic phase. In fact, one usually runs into these questions time-and-again, as the project progresses, and fundamental research questions might well be the outcome of such a project. Diagnostic studies relate especially to questions 3–6 above and, if done before answering questions 1 and 2, will help to be more selective in answering questions 1 and 2, making the research more relevant and efficient.

Epistemological positioning of the questions

The relevance of the six questions can be underscored by using 'Miller's Quadrants' (Figure 1).

Figure 1 has become widely accepted within Wageningen University as a way to distinguish different research paradigms, in the understanding that all of them are important (e.g. Röling, 2003). Miller (1983; 1985) was a Canadian scientist involved in the battle to eradicate the spruce budworm, a pest that was devastating the spruce paper wood forests in New Brunswick Province. He watched his colleagues' ways of dealing with the spruce budworm. Some (Quadrant I) had very disciplinary, reductionist and technical perspectives and focused on the pest in isolation. Others (Quadrant II) saw the budworm as an organism that is part of an ecosystem. Their solution included use of natural enemies and other typical IPM approaches. Miller found only few colleagues with a perspective that included people's reasons and activities as part of the problem (Quadrant III), although a key factor in the budworm outbreak was the fact that vast tracts of land had been planted with the same species of tree for reasons of commercial profit. Those in Quadrant III saw the need for constructing critical

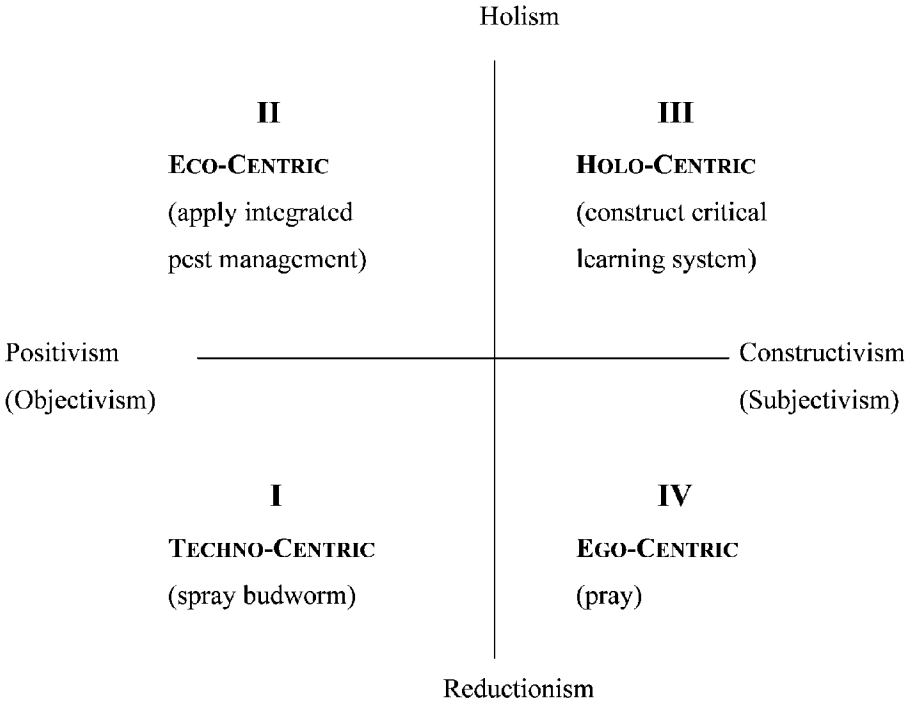

Figure 1. Four expert reactions to the spruce budworm pest, based on different paradigms. Adapted from Miller (1983; 1985) and Bawden (2000).

learning systems as a key to the solution. There was no one in Quadrant IV. By suggesting 'prayer' as a solution in this quadrant, Miller seems to say that spirituality might be an important element in agricultural research. We concur (Millar, 1996; Van Eijk, 1998) but leave this issue for others to pursue.

When a scientist, or a whole research institution for that matter, is stuck in Quadrant I, useful work might still be produced. But the scientists involved are unable to look over the edge of the box and can make only limited contributions to transformation in society. To be useful, scientists and research institutions must be able to 'think' the paradigms of Quadrants I, II and III simultaneously.

If we now return to Tekelenburg's (2002) questions, it is not difficult to see that questions 1 and 2, the conventional questions of agricultural research, fit in Quadrant I. Questions 3 and 4 fit into the 'hard' systems perspective of Quadrant II. And questions 5 and 6, and to some extent question 4, cannot be answered satisfactorily without interactive research, i.e., without full involvement of relevant stakeholders.

What remains an enigma, even to Tekelenburg, is how to design and manage the different research tasks in a project so that all the questions get answered. This challenge implies making effective linkages, not only with farmers, but also with other stakeholders, such as fundamental research institutions and marketing chain actors.

It is not a question of becoming a naïve populist – an advocate of making the whole process subservient only to farmers' demands – but rather one of mediation between different viewpoints and of teasing synergy from potentially complementary contributions through bringing stakeholders into a new relationship.

Criteria for the quality of pre-analytical choices

If we now come back to possible criteria for the quality of pre-analytical choices, we conclude that a research project that makes a difference in terms of development and poverty reduction must be able to answer all six questions. This means paying considerable attention to questions 3–6, which are all too often neglected. The quality of the pre-analytical choices determines the extent to which all these questions can be answered. For example, did the allocation of time and money to the project allow answering questions 3–6? Did the choice of a research process allow negotiation of research goals and experiments with representative farmers? Was the choice of objectives dictated by an analysis of the context and windows of opportunity? To what extent were choices originally adapted as a result of exploratory work? The CoS technographic studies and the diagnostic studies have sought to answer questions 3–6. At the time of writing, the PhD researchers were busy answering type 1 and 2 questions.

We leave it at that. It is not useful at this stage to develop a comprehensive framework for a deductive exercise. It is much more exciting to examine the nature of the choices that were made in the CoS project and in the diagnostic studies and then, in the concluding article to this special issue (Nederlof *et al.*, 2004), to come back to the quality of the choices made on the basis of what we learned from the diagnostic studies.

An examination of some of the choices that were made before the diagnostic studies

We begin by re-iterating our fundamental point that pre-analytical choices cannot be avoided. They are neither good nor bad in themselves. The point is to understand how and why they are made, and what effect the choices have on the subsequent ability of the research project to have a development impact. In this connection we must ask: What were some of the major choices that the CoS team made *before* the diagnostic studies? This is not an exercise that we, or our colleagues, found easy. One has to 'bare one's bottom' for the simple reason that, in hindsight, we might have done things differently.

Differences between Ghana and Benin

The studies in Ghana and Benin did not come out of the blue. In Benin, the CoS project can be seen as a sequel to a successful research project featuring IPM Farmer Field Schools in cowpea (*Vigna unguiculata*). To a considerable extent, the people involved in the CoS project are the same as the members of this previous project.

In Benin, cowpea was chosen as one of the crops on which the CoS project would focus as a result of this earlier project. Cowpea is widely consumed, and the local people consider its seeds as equivalent to meat. Other parts of the plant, the leaves and the pods, are consumed as well. The crop plays an important role in ceremonies and can be considered as an important local cash crop.

The Cowpea Project, which preceded the CoS project, also had an important implication for the way the diagnostic studies in Benin were carried out. In Ghana the researchers quickly zoomed in on a few specific villages and groups of experimental farmers with whom they negotiated the experimental work. In Benin each of the students first did an 'exploration' involving many villages and areas, only later to engage in an 'in-depth' diagnosis together with local people in a few villages. At first, the term 'diagnostic study' was used in Benin only for the 'exploration'. This led to some confusion before we had discovered that we were talking of a diversity of practices (see Nederlof *et al.* (2004) for more explanation). In the articles for this special issue, most Beninese authors have included their in-depth diagnosis as well.

The choice of research subjects and crops

Another important pre-analytical choice concerns the subjects that might be covered by the CoS project. For example, Wageningen Departments could not justify their participation if the study did not reflect their field of expertise. This is reflected even in the title of the project. Such a choice is necessary. A project cannot solve every problem and a focus on, say, soil biology can still allow for an important contribution because soil life is an important issue in soil fertility management in West Africa. But the fact remains that the CoS project did not, for example, include animal science or economics. We are not aware that the choices for including or excluding disciplines or subjects were made deliberately or for any other reason than the enthusiasm of particular individuals and departments to participate in the project. In Ghana prior connections with Extension Studies in the Faculty of Agriculture gave rise to a situation in which it took time and deliberate effort to mobilize enthusiasm in other, especially

Table 1. Crops, agro-ecological zones (AEZ) and research topics chosen by the CoS project in Ghana and Benin.

Type of crop	Ghana			Benin		
	Crop	AEZ	Topic	Crop	AEZ	Topic
Orphan, traditional or grassroot crops	Sorghum	Savannah zone	Plant genetic diversity	Sorghum	Savannah zone	Plant genetic diversity
Private interest crops	Cowpea	Transition zone	Soil fertility Plant genetic diversity	Cowpea	Transition zone	Plant genetic diversity Soil fertility
Cash or public crops	Cocoa	Forest zone	Integrated pest management	Cotton	Savannah zone	Integrated pest management

technical departments.

As early as summer 2001, a meeting in Wageningen with partners from Ghana and Benin established a basic framework for identifying the choices that had been made before any research work was undertaken. Table 1 summarizes these choices.

These decisions were made after due consideration of the following factors. We wanted a diversity of agro-ecological zones. We also wanted different types of crops, including:

1. *Public interest crops* such as cocoa and cotton, which are characterized by heavy involvement of the state, where a marketing chain is in evidence, and which have been backed by public research and extension.
2. *Private interest crops*, which are not marked by heavy intervention from the state and which still leave room for private commercial initiative.
3. *Orphan, traditional or grassroot crops*, which receive less attention from development organizations, have been neglected by public research, and for which markets seem less well organized. The slow loss of terrain of sorghum and its replacement by maize as a staple food was a reason to focus on sorghum.

The range of crops seemed also to allow the CoS project to look at different research contexts and research processes, and compare similar crops across the two countries, i.e., research systems operating within an Anglophone and a Francophone tradition.

That these choices had considerable implications can be gleaned from the fact – and this happened before any research work was done in the field – that the researchers were dissuaded from their own initial interests. One student wanted to work on cashew as a dynamic private interest crop but had to accept that he should work on cocoa. Another wanted to work on plantain but ended up working on soil fertility and a third was keen on examining the genetic diversity of tomato but had to transfer this interest to sorghum.

The choice of a crop for inclusion had consequences that might already limit research impact. For example, the sorghum researcher found that maize is gradually taking over as a staple in the area in which she is working, and also that millet plays crucial and novel roles. In a way then, the choice for a crop focus takes away interest from the farming system as a whole and introduces blind spots that require extra energy and reflection to be overcome (Kudadjie *et al.*, 2004). In all, in hindsight, we may have unnecessarily limited our degrees of freedom when choosing for crops.

After the decision to focus on particular crops and the thematic interests aligned with each (see Table 1), the need, as perceived by the researchers, to pay specific interest to soils led to the inclusion of a project in each country explicitly focused on soil fertility (Adjei-Nsiah *et al.*, 2004; Saïdou *et al.*, 2004). Similarly, the enthusiasm in Wageningen for what they call 'Beta/Gamma approaches', i.e., research approaches that include human behaviour in agricultural research (Figure 1, Quadrant III), led to the decision to include social sciences. Both social and natural scientists supervise each researcher. Similarly, it was considered important that scientists from Africa and the Netherlands equally be involved in providing guidance. As a result the researchers had to develop the skills to strategically manage a team of at least four supervisors.

The choice of researchers

A final point is that each person has entered the project with specific enthusiasms, convictions, disciplinary backgrounds, etc. Such life choices play an important part in determining the outcome of any research. The way to ensure that the background of a researcher fits the requirement of the project is through the recruitment procedure. Recruitment for the CoS project took place before any field research, partly because university procedures required PhD researchers to prepare their proposals and undergo training before their projects begin. So in a number of cases, the diagnostic studies represent a way of *testing* a pre-conceived choice already made by a researcher, rather than a more open-ended exploration that would inform the making of such choices.

Conclusion

It is clear that pre-analytical choices can severely affect the ability of agricultural research projects to zoom in on the most promising windows of opportunity for farmers. On the other hand, the examples given here also make clear that pre-analytical choices are inescapable and are not necessarily detrimental in themselves. A research project cannot do everything. Limiting one's degrees of freedom is not necessarily bad. But it is clear that the diagnostic study is not so much a totally open-ended activity that allows field realities to 'emerge', but an occasion for 'reality testing' and negotiation with farmers and the other stakeholders who have to live by the results.

Technographic studies

As already noted, the CoS project used two approaches to making explicit pre-analytical choices: the technographic studies and the diagnostic studies. Although this special issue focuses on the diagnostic studies, it is necessary to briefly describe the technographic studies here because their outcomes determined choices that were further examined and developed in the diagnostic studies.

The technographic studies were done at the prompting of Richards (2001). They explored the innovation landscape for the six major crops that the CoS consortium had chosen (Table 1) and were carried out by mixed teams of Ghanaian and Beninese PhD supervisors. The studies looked at the technological histories, markets, institutions, framework conditions, stakeholders, and contextual factors at a higher macro level than the diagnostic studies. In a way, the technographic studies can be compared to a Rapid Appraisal of Agricultural Knowledge Systems (RAAKS, Engel & Salomon, 1997). Here we do not want to go in depth into the methodologies used and results produced. It is sufficient to mention a few important outcomes.

The technographic studies observed that farmers, both in Ghana and Benin, were using cassava as a major strategy for restoring soil fertility, an idea that many scientists would consider both unlikely and ineffective. As a result, the two soil fertility studies have included cassava in the experiments. In fact, the inclusion in the diagnostic studies of soil fertility as a subject by itself was based on the conclusion of the technographic studies that soil fertility was a domain for which innovations were

required, independent of specific crops. Also as a result of the technographic studies, weed management was validated as a justified focus in Benin. In their respective articles in this issue, the authors make clear their debt to the technographic studies in one way or another.

Final remarks

The special issue of NJAS that lies before you reports on a somewhat rare experiment. It is a deliberate effort to make explicit choices in research design and implementation and establish research processes that optimize the chances that small-scale farmers benefit. We have established that the context is constraining. In fact, one can justifiably place question marks behind the choice to make technology development the focus in the first place. From the perspective outlined in this introduction, the diagnostic studies in the CoS project are just a first step in a longer process of developing multi-stakeholder learning processes around the creation of realistic opportunities for small-scale farmers. The diagnostic studies themselves represent a serious effort to initiate a link between the innovativeness of small-scale farmers and the capacity of organizations and institutions at a higher scale level to create opportunities. The diagnostic studies are a way to shape an interface between local dynamics (Hounkonnou, 2001) and the institutional capacity of the public and private sectors to create (inter)national public goods. Can diagnostic studies make a difference? We hope that this special issue will help readers to make up their own minds.

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