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ECOREGIONAL RESEARCH IN AFRICA: LEARNING LESSONS FROM IITA'S BENCHMARK AREA APPROACH

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SUMMARY

Ecoregional research has the potential to help address some of the huge challenges facing agriculture in developing countries by developing technologies that work under different agro-ecological conditions, and the processes by which these technologies can be adapted to work in other areas with similar conditions. The CGIAR system has been developing ecoregional research as a new paradigm for over a decade. In this paper we evaluate one of the most ambitious of these initiatives called the Benchmark Area Approach (BAA) pioneered by the International Institute of Tropical Agriculture. We evaluate the BAA against nine good practice criteria for ecoregional research and finding that the approach is delivering, or has the potential to deliver, on all nine. Many of the lessons learnt from this evaluation will be relevant to current and future attempts to undertake co-ordinated multi-locational research for development.

INTRODUCTION

Agriculture in developing countries faces a huge challenge. In the next 50 years, the number of people living in the world's poorer countries will increase from 5 billion to nearly 8 billion (Population Reference Bureau, 2001). Moreover, per capita food production needs to increase to feed the 1.1 billion underfed people in the world (Gardner and Halweil, 2000). This means farmers in 2050 will need to produce at least 50 % more food from a natural resource base that is already damaged by human activity to the point where further degradation could have devastating implications for human development and the welfare of all species (World Bank, 2000). Nowhere are the problems more severe than in sub-Saharan Africa where population is expected to grow by 132 % by 2050 and where more than one third of children are already underweight.

The Consultative Group on International Agricultural Research (CGIAR), consisting of a global network of 15 international agricultural research centres, helped catalyze the Green Revolution which side-stepped a similar Malthusian crisis that threatened in the 1960s. A second Green Revolution is now needed, and the CGIAR system believes that it has a role to play in bringing it about. However, the situation

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today is dramatically different. Expanding the production of cultivars with high genetic potential on irrigated land will not work again, because land that can easily be irrigated is already irrigated. Moreover, with the exception of irrigated rice and wheat, the lack of high yielding cultivars is not a serious constraint to increased and sustainable food production (CGIAR/TAC, 1993). Hence, the CGIAR system needs a new research paradigm, one that can 'combine genetic enhancement with improved management of the natural resource base' (CGIAR/TAC, 1993, p. 2). In contrast to the past, the research underpinning the second Green Revolution needs to work much more with the grassroots, helping to build solutions that rely more on local knowledge and less on a 'one size fits all' application of simple technologies and chemical inputs.

Nevertheless, the second Green Revolution will also need to be built on international public goods, that is, technologies and knowledge that are broadly applicable, otherwise research and extension will be too expensive. The problem of doing location-specific research that yields international public goods is well understood by the International Institute of Tropical Agriculture (IITA), which is based in Ibadan, Nigeria, and works in sub-Saharan Africa. Sub-Saharan Africa has far less irrigated land than Asia and the first Green Revolution never properly took hold. Farming systems remain 'fine-grained' with each grain representing a farming system with a different set of resource endowments and constraints (Smith and Weber, 1994). Consequently, IITA has been working for more than ten years to develop an ecoregional research approach that can be an effective catalyst for agricultural development in heterogeneous farming systems. In doing so, IITA has drawn on the ideas of benchmark areas and ecoregional research being developed in six other ecoregional programmes co-ordinated by other CGIAR Centres. In IITA's case, the result is the Benchmark Area Approach (BAA) in which IITA works with a wide consortium of stakeholders, from individual farmers to international research institutes, to address the whole research and development (R&D) continuum in a limited number of benchmark areas and pilot sites, strategically located to represent a diversity of biophysical and socio-economic conditions.

IITA implemented the BAA in West and Central Africa. The rationale is that this keeps IITA's research demand-driven, while at the same time building the capacity of National Agricultural Research and Extension Systems (NARES) to carry out natural resource management (NRM) research. Building NARES capacity is critical because the location-specific nature of NRM problems means that NARES, not CGIAR centres, must deal with NRM research issues in the longer term.

This paper describes and evaluates the BAA as an approach of implementing ecoregional research. The objective of the paper is to learn lessons from IITA's experience that will help current and future attempts to undertake co-ordinated multi-locational research for development.

MATERIALS AND METHODS: THE EVALUATION APPROACH

Although the BAA been evolving over the past nine years, this is not long enough to have measurable effects on people's livelihoods. Collinson and Tollens (1994) gave an idea of the time frame to achieve impact when they said it can take 10 years to move from basic research to a useful technology and then another 10 years to see its full impact. Here, we evaluate the BAA against good practice, as described in the literature, of how to bring sustainable, cost-effective benefits to small-area farmers. Our premise is that if the BAA is a close match to existing good practice, then the BAA is more likely to have widespread impact in farmers' fields than if it does not. To think otherwise would be to question the validity of a whole body of literature.

Patton (1997) identifies three types of evaluation: 1) to judge merit or worth, 2) to generate knowledge, and 3) to improve projects and programmes. Our aim in this paper is to help improve future projects and programmes that are considering using ecoregional research approaches by learning the lessons from IITA's experience.

Establishing good practice in bringing sustainable, cost-effective benefits to farmers in complex systems

The CGIAR system was set up in 1971, comprising just four research institutes that were primarily concerned with plant breeding. Natural resource management (NRM) has gained importance since then, propelled in part by the publication of the Brundtland Report in 1987 (Brundtland Commission, 1987), which alerted the world to the urgency of making progress toward economic development that could be sustained without depleting natural resources or harming the environment. In response, the CGIAR system broadened its objectives from increasing food production to include sustainable development. This supported an evolution that was already taking place, based on experiences in farming systems research (FSR) (Collinson and Lightfoot, 2000), towards more holistic and multidisciplinary approaches to NRM. In 1996, the CGIAR system coined the term 'integrated natural resource management' (INRM) as an umbrella term to describe the results of this evolution (CGIAR/TAC, 1997). In 1998 the third external system review (CGIAR Secretariat, 1998) recommended that the CGIAR system set up a network to strengthen centres' ability to carry out INRM. This was a result of the recognition by the review panel that a paradigm shift had occurred in good practice, in which 'hard' reductionist science was being tempered by 'softer' more holistic approaches. Specifically, the review identified a move from classical agronomy to ecological sciences, from analytical research to systems dynamics, from top-down to participatory approaches, and from factor-oriented management to integrated management. The review also saw INRM specifically as a mechanism for better integrating work on genetic improvement with NRM (Izac and Sanchez, 2001).

INRM now represents current good practice in natural resource management in international agricultural research (CGIAR/TAC, 2001a). One of the most important differences between INRM and earlier approaches to NRM in the CGIAR is that INRM sees end-users as an essential part of the R&D process, while previous approaches, for example the 'transfer of technology' approach, did not. INRM sees agricultural development as a complex, non-linear and social process, while the 'transfer of technology' approach views it as a top-down, linear process, with end-users doing little more than deciding whether to adopt, or not to adopt. Another difference is that the management of genetic resources is seen as part of INRM.

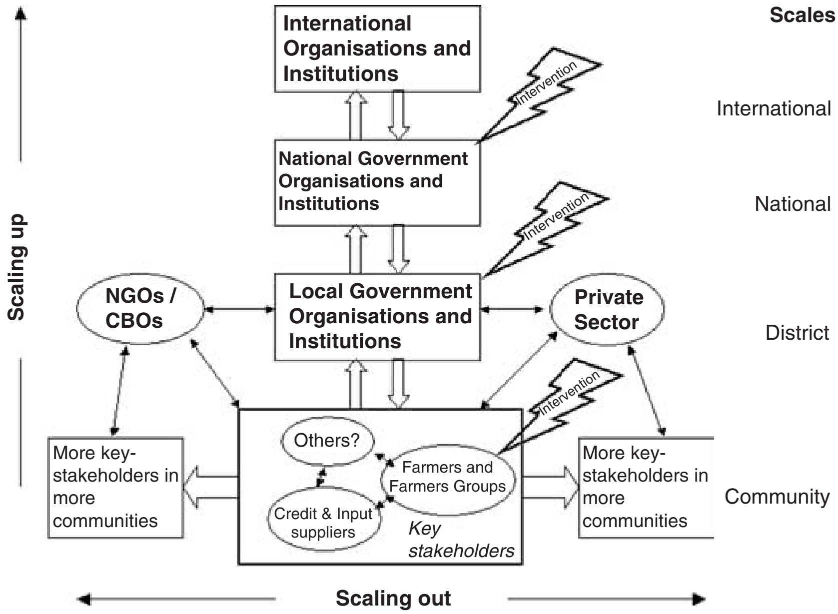

Figure 1. Concepts of vertical and horizontal scaling-up. Note: CBO = community-based organization. Source: Douthwaite *et al*. (2003), adapted from IIRR (2000).

The INRM view of the role of end-users in the R&D process requires a move from on-station research, where researchers develop technologies by themselves, to on-farm research, where technologies are developed together with the end-users, – in other words, a move to more participatory approaches. However, developing technologies together with farmers by necessity means working, at first, in a few pilot areas. To justify international research investment, these technologies, and the processes by which they were locally developed and adapted, need to be scaled-out and scaled-up, so more farmers can benefit. The concepts of scaling-out and scaling-up are therefore crucial to INRM in the CGIAR system. However, the terms have several meanings. Here, we distinguish between two types:

1. Scaling-out – innovation spreads from farmer to farmer, community to community, within the same stakeholder groups.
2. Scaling-up – an institutional expansion from grassroots organizations to policy-makers, donors, development institutions, and other stakeholders key to building an enabling environment for change.

Scaling-out and scaling-up processes are illustrated graphically in Figure 1. The two are linked, because as a change spreads further geographically, the greater the chances of influencing those at higher levels, and, likewise, as one goes to higher institutional levels, then the greater the chances for horizontal spread.

Good practice INRM (Sayer and Campbell, 2001), together with this understanding of scaling-out and scaling-up, gives us the criteria against which we can assess the BAA developed by IITA. To comply with best practice the BAA should:

1. Be able to blend together both 'hard' and 'soft' science in such a way as to develop at the local level technical solutions and processes that work and are adopted, and then to scale these experiences out and up (see Figure 1).
2. Accept that there are multiple stakeholders with multiple realities, and that making sustainable improvements to rural peoples' livelihoods requires understanding of many of these realities and engaging with many stakeholders.
3. Given this, attempt to effect change by helping stakeholders to envision preferred scenarios and then encourage the stakeholders to move in these directions through iterative and interactive experiential learning cycles. Involving higher level stakeholders early on is important to scaling-up (see Figure 1).
4. Accept that problems must first be solved, and processes developed, at the local level before they can be scaled-out and -up.
5. Support the central role of social and experiential learning though a number of tools, including monitoring and evaluation, based on commonly agreed indicators, and modelling future scenarios to support negotiation and decision-making.
6. Use characterization and Geographic Information Systems (GIS) that help change agents identify best bet technologies and processes.
7. Support the formation of knowledge networks[1] built on a common set of concepts and databases that emerge from initial characterization work. The knowledge networks are the basis for scaling-up and -out.
8. Consider effects at different spatial and temporal scales using the systems hierarchy concept[2].
9. Remain practical and problem-oriented – building researcher and resource-user partnerships requires researchers to come with something useful in the first place.

RESULTS

In this section, we examine the evolution of the BAA. In the next section, we compare the current BAA with the good practice criteria described above.

The role of EPHTA

The BAA was the conceptual backbone and modus operandi of the Ecoregional Programme for the Humid and Sub-humid Tropics of sub-Saharan Africa (EPHTA), one of seven ecoregional programmes co-ordinated by CGIAR centres. Hence, for us to understand and evaluate the BAA, we must first know something about EPHTA and the thinking behind ecoregional programmes. Moreover, EPHTA ceased to exist

[1] By BAA knowledge networks, we mean the network of people who engage in on-going conversations about various aspects of the BAA including characterization and the innovations being developed.

[2] The system hierarchy concept states that to understand a system it is necessary to understand the systems directly below and above it in a hierarchy of systems. For example, to understand what is happening in a farmer's field it is necessary to understand the system at the level of the soil and also at the level of the community (Bossel, 2001).

in 2002. Understanding why this happened, and what remains of the BAA two years later is important in an evaluation of the utility of the BAA.

The drive for the CGIAR system to set up ecoregional programmes came from a 1991 TAC report called 'An Ecoregional Approach to Research in the CGIAR' (CGIAR/TAC, 1991). TAC proposed an ecoregional approach as the new research paradigm that was needed, and as one that could combine genetic enhancement with NRM, and perhaps serve as the basis of the second Green Revolution.

Central to the ecoregional approach concept was the acknowledgment that NRM technologies were location-specific, and not general, as much of the CGIAR system's plant breeding work had been. However, in setting-up and running ecoregional programmes, CGIAR centres would not primarily be developing location-specific solutions but rather carrying out 'research on research' to identify processes by which technologies were developed and then scaled-up to benefit more people. If they were more widely applicable, then these technologies and processes would be international public goods, to be used by NARES and others: exactly what the CGIAR system is mandated to produce.

Agro-ecological zones and the placement of representative research sites within them were also central to the ecoregional programme concept. An agro-ecological zone (AEZ) is an area with similar agricultural and ecological characteristics, with a specific boundary. The AEZ concept grew out of FAO's work in mapping the world using climate, soil and terrain criteria in the late 1970s and early 1980s. An AEZ map, together with knowledge of the growth requirements of different crops, allows researchers and policy makers to better target their technologies, research and policy interventions (Collinson, 2000).

EPHTA was one of the first ecoregional programmes to be set up. It was officially launched in April 1996 after a 2-year preparation period during which the BAA, which underpins it, was developed. The distinguishing features of the BAA are discussed below.

Distinguishing features of the Benchmark Area Approach at IITA and its start-up process

Large benchmark areas. AEZs can be vast and diverse. Hence CGIAR/TAC (1993) came up with the idea that ecoregional programme research sites should act as 'incubators' for technologies and processes that would then be extrapolated more widely. IITA's contribution was to argue that the research and extrapolation process would be helped if research sites were selected within a benchmark area large enough to capture typical *variations* in agro-ecological and socio-economic conditions found in the wider AEZ. Large benchmark areas would allow work on three important dimensions:

- Appraising institutional and policy factors driving the evolution of farming systems;
- Working with a broad stakeholder partnership which is essential to establishing knowledge networks required for scaling-up;
- Building NARES capacity in new research and extension methods, including participatory approaches.

Table 1. EPHTA benchmark areas.

Benchmark Areas	Country	Host institute
Moist savannah AEZ		
Northern Guinea savannah	North Nigeria	Institute of Agricultural Research (IAR)
Southern Guinea savannah	Ivory Coast	L'Insititut des Savanes (IDESSA)
Derived coastal savannah	Bénin	L'Insititut National des Recherches Agricoles du Bénin (INRAB)
Humid forest AEZ		
Forest margins	Cameroon	Institute of Agricultural Research for Development (IRAD)
Forest pockets	Ghana	Council for Scientific and Industrial Research (CSIR)
Degraded forest	Southeast Nigeria	National Root Crops Research Institute (NRCRI)

Process of choosing benchmark areas. Having decided on large benchmark areas, the next step was to choose how many and where they should be. Two preparatory workshops were held which proposed that there should be three benchmark areas in each of the two AEZs that EPHTA covered. The need for several benchmark areas in one AEZ reflected the huge area covered by the Moist Savannah AEZ and the Humid Forest AEZ in West and Central Africa – 221 million km^2 (IITA, 1997) – and the great array of socioeconomic conditions with in them.

With the broad guidelines set, the actual siting decisions were made, based on a combination of scientific, pragmatic, and political considerations. The stakeholders agreed that the benchmark areas should not span national borders and that each should be centred on a NARES station that could act as a host. Southeast Nigeria was an obvious choice for the degraded forest benchmark area because is has the highest population density of any humid forest area in West Africa. IITA already had research stations in northern Nigeria and southern Cameroon which made these areas clear choices for the Northern Guinea Savannah (NGS) and Forest Margin (FM) benchmark areas respectively. Ivory Coast and Ghana could both have hosted either a savannah or a forest benchmark area but, in the end, the countries negotiated that Ivory Coast take a savanna benchmark area and Ghana host a forest one. The remaining savanna benchmark area went to Benin, partly because IITA had a station there and partly because of some good on-going farm work including work on *Mucuna* (e.g. Versteeg *et al*., 1998).

Once the NARES leaders had agreed the general areas, and political support had been built for these decisions, the next step was delineating the boundaries. This was largely a technical process that involved scientists from IITA and NARES, guided in Cameroon by a natural resource management survey (Baker and Dvorak, 1993) and by macro-characterizations of agriculture in West and Central Africa (Manyong *et al*., 1996a; 1996b).

Table 1 and Figure 2 shows the benchmark areas chosen. The Moist Savannah benchmark areas were delineated based on the length of the growing period (LGP), as this was the standard practice in defining research areas and extrapolation domains in IITA and NARS at the time. However, this approach made less sense for siting the benchmark areas in the Humid Forest AEZ and instead population density and

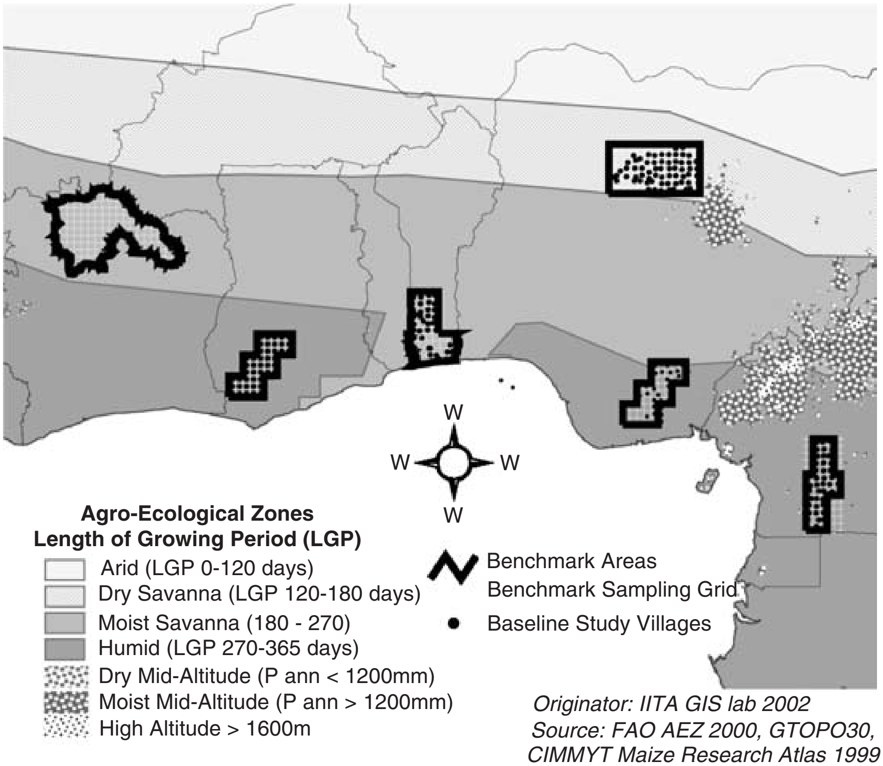

Figure 2. EPHTA Benchmark areas in West and Central Africa. Note that the AEZs in this map reflect a revision in nomenclature made by IITA and other organizations since 2000.

degradation indicators were used. In Table 1, population pressure increases from FM benchmark area to Degraded Forest area while rainfall decreases from the NGS benchmark area to the Derived Coastal Savanna benchmark area.

Stakeholder participation. From the outset, IITA went to great lengths to foster the participation and buy-in of the NARES stakeholders in the region. In the two year start-up period, the IITA-appointed EPHTA programme co-ordinator made two rounds of visits to 15 countries in West and Central Africa to discuss the proposed ecoregional approach with NARES leaders. IITA's Director General and others had intense discussions with the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) and the Food and Agriculture Organization (FAO) to encourage their buy-in and involvement (IITA, 1997).

As a result of this effort, senior research directors from 11 of the 15 countries attended the EPHTA launch in April 1996 and agreed to an action plan and a five year budget proposal. The action plan was remarkable in that all organizations committed real resources to EPHTA. Unfortunately, the budget proposal was never approved by the donor community and with limited resources EPHTA was only able to function at a greatly reduced capacity. The BAA was most intensively implemented in the FM and

NGS benchmark areas where field research on INRM by IITA has been conducted using core and special project resources, and has continued since the official ending of EPHTA in October 2001. Another remarkable feature of the work plan was the level of compromise to which organizations agreed in favour of partnership. For example, some countries agreed to give up benchmark areas in exchange for smaller pilot sites where technologies would also be tested as part of the scaling-up process.

Another example of negotiation was the agreement reached on initial EPTHA research targets that were a match between what IITA could offer and what NARES wanted. One such research target was the decision to work on maize-legume intercrop systems in the savanna. IITA submitted aspects of this work for the prestigious King Bedouin Award for 2002.

Governance of the benchmark areas was through steering committees, which were also seen as a mechanism for cementing information sharing, priority setting and collaboration in general. So far, however, only the NGS, the FM and the Degraded Forest benchmark areas have steering committees appointed, with an average of nine stakeholders on each, including farmers' organizations, a private sector seed company, international agricultural research centres (IARCs), non-government organizations (NGOs), universities, and extension services. However, the committees do not meet regularly because of the lack of funding.

'Dynamic nature of farming systems' paradigm. Central to the whole BAA was the idea that farmers' NRM practices and decision-making change over time, and these practices and changes are influenced by various factors. Among the most important drivers of change are population pressure (Boserup, 1965; Binswanger and McIntire, 1987) and the institutional development of markets combined with access to those markets (Pingali *et al*., 1987). These have very important implications for scaling-up. It means that while farmers' NRM decisions might appear to be location-specific at the farm or community level, viewing these decisions as a system response, allows the prediction of similar responses based on an analysis of demographic and market data. This made 'back-targeting' possible, that is, predicting the way farming systems were likely to evolve from experience elsewhere within the benchmark area, and then using this prediction to target interventions which could be expected to be compatible with farmers' evolving livelihood strategies. In this way, the dynamic paradigm dealt with the criticism of FSR that it did not take into account the dynamic nature of farming systems (Maxwell, 1986).

Benchmark area characterization. Putting the dynamic paradigm into practice required characterizing the benchmark areas in terms of population density and market access variables. Figure 3 shows the different scales on which the benchmark area characterization took place on.

Evolution of the Benchmark Area characterization tool

Prior to the launch of EPHTA (1985 to 1995). The BAA dynamic characterization tool evolved from work in the late 1980s as part of a US Agency for International

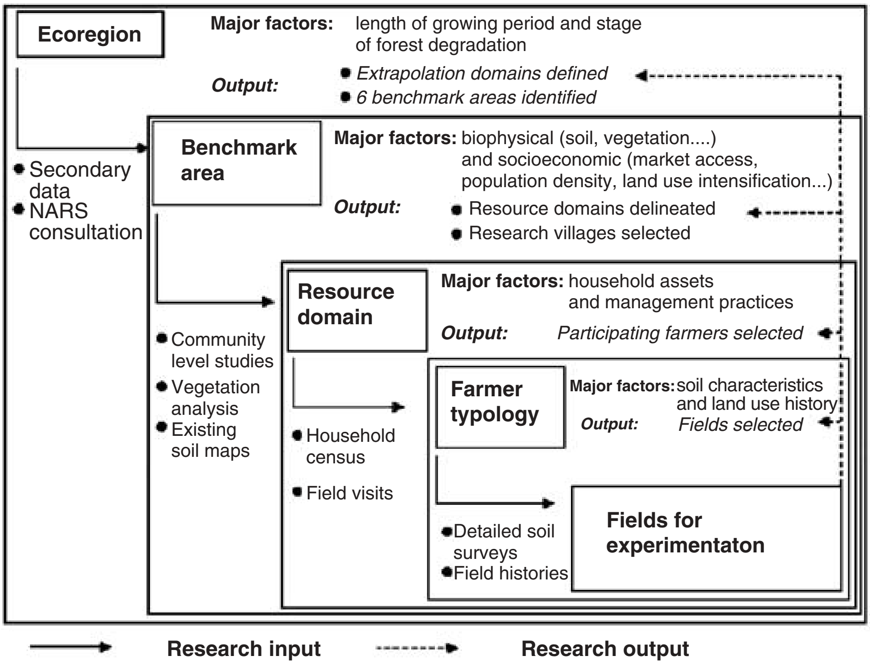

Figure 3. Framework for benchmark area development. Source: Brader, 1998.

Development (USAID) – Institute of Agricultural Research for Development (IRAD) – IITA project in Cameroon, called the National Cereal Research and Extension (NCRE) Project. As part of the NCRE project's efforts to set priorities, a survey to characterize differences in natural resource management by farmers in the major ecological zones of Cameroon was conducted using a survey tool designed to test hypothesized responses to increasing market access and population pressure. These responses are shown in Table 2.

The NRCE sampling approach was to overlay an AEZ map of Cameroon with a 10 minute by 10 minute grid, randomly select 10 % of the cells, and then send survey teams to conduct interviews in the village closest to the centre of the selected cells. Each cell has an area of 343 km^2. The survey began with village-level group meetings that then broke up into three groups to fill out a structured questionnaire based on the hypotheses encapsulated in Table 2. Multivariate analysis was then used to identify trends in resource use correlated to market access and population pressure.

In 1993, three years before the launch of EPHTA, the CGIAR initiated the Alternatives to Slash and Burn (ASB) system-wide initiative coordinated by the World Agroforestry Centre (ICRAF). The overall objective of the initiative was to develop sustainable approaches for rural development in the wet tropics that would minimize the environmental loss caused by deforestation resulting from slash and burn agricultural techniques. IITA and IRAD were nominated to co-ordinate and develop a FM benchmark area in Cameroon. IITA and IRAD decided to build on the

Table 2. Hypotheses underpinning the BAA survey tool on what is driving evolutionary change and how farmers might respond to them (adapted from Baker and Dvorak, 1993).

Drivers of evolutionary change	Farmer responses to these pressures
1. Population pressure 2. Access to market	*Crop patterns and land use* – Shortening fallow periods-Increased use of inputs (e.g. pesticides, organic and inorganic fertilizer) – Intensified soil management practices – Field type and crop pattern differentiation
	Monetization of production enterprises – Use of purchased inputs – Increased food purchases – Increased sales of crop products
	Household economy – Livestock becomes more important relative to hunting and fishing – More non-crop income sources – More off farm income – More salaried income compared to income from bush products and artisan activities

NCRE work to delineate and characterize the FM benchmark. The two organizations subsequently identified the benchmark area shown in Figure 4. Previous NCRE multivariate analysis of the NRM survey identified three relatively homogenous blocks in terms of farming systems and use of resources. The analysis also showed a north–south population gradient with relatively high population densities in the north around Yaoundé and lower densities in the south. The benchmark area covered 45 contiguous 10 minute by 10 minute cells with an overall area of 15 000 km^2. Each of the three blocks consisted of 15 cells.

In 1993 and 1994, the ASB group administered a highly abridged version of the NCRE survey tool in all of the 45 cells, as well as a quick characterization of soil properties and vegetation cover. Multivariate analysis of the data generally confirmed the intensification gradients and the similarities within blocks identified by the NCRE work. The ASB group also used multivariate analysis to select two research villages in each block by determining which villages were most representative of block traits. Villages with atypical soils, or which were inaccessible during the rainy season, were not considered. Six research villages were chosen.

In 1994, Joytee Smith and Georg Weber published a paper that had an important influence on the BAA in IITA. Smith and Weber's insight was that population-driven agricultural intensification followed a different trajectory than market-driven intensification Up to this point it was assumed that the effects were the same. They noted that systems driven primarily by increasing population pressure start by expanding the area under cultivation. When no more land can be cultivated, either because there is no new land available or because farmers do not have access to it because of ownership issues, an intensification period begins. Fallow periods fall to below the time needed to replenish soil fertility, and crop yields fall as a result. In general, returns to land and labour fall in population-driven systems that are intensifying.

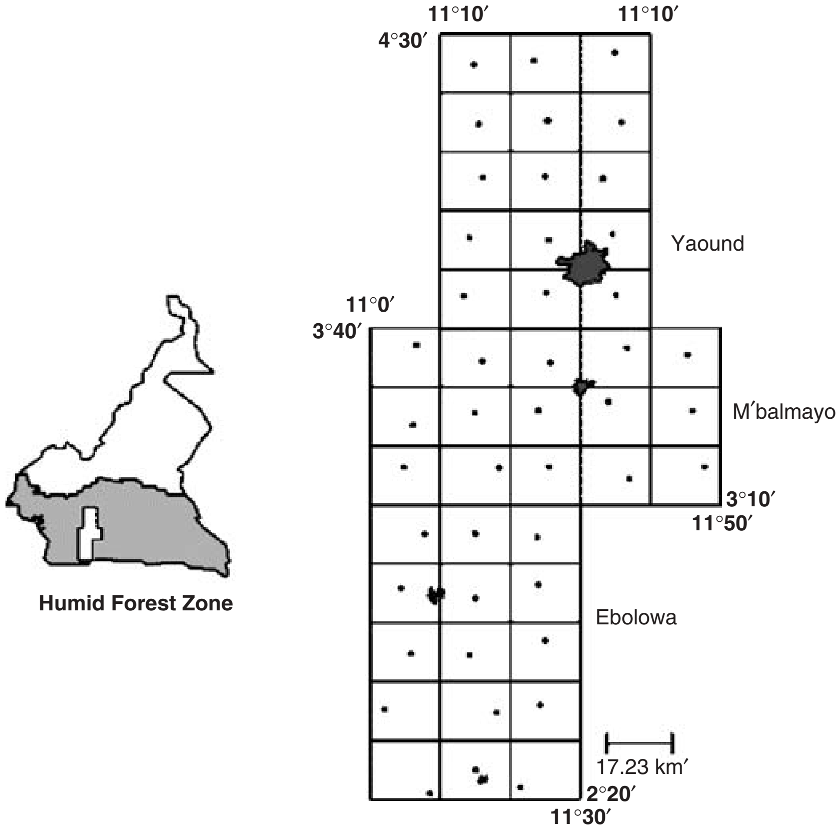

Figure 4. Forest Margin (FM) Benchmark Area showing the 45 sampled grid cells.

Smith and Weber also noted that if communities had good access to markets then the evolutionary path was very different. Market-driven systems also go through an expansion phase but are driven by a profit motive rather than by the need to feed more people. Once access to new land becomes difficult, then profits from selling produce in the market are used to buy external inputs, such as fertilizer and improved seed. Fallow periods fall but soil fertility does not decline so quickly, and returns to land and labour increase.

Based on these two separate evolutionary paths Smith and Weber distinguished four types of resource-use domain, each of which would have different sets of constraints and priorities:

1. Population-driven systems in the land expansion phase.
2. Population-driven systems in the land intensification phase.
3. Market-driven systems in the land expansion phase.
4. Market-driven systems in the land intensification phase.

This classification was used in a macro-characterization of West Africa (Manyong *et al.*, 1996a) and Central Africa (Manyong *et al.*, 1996b). Weber and Smith were

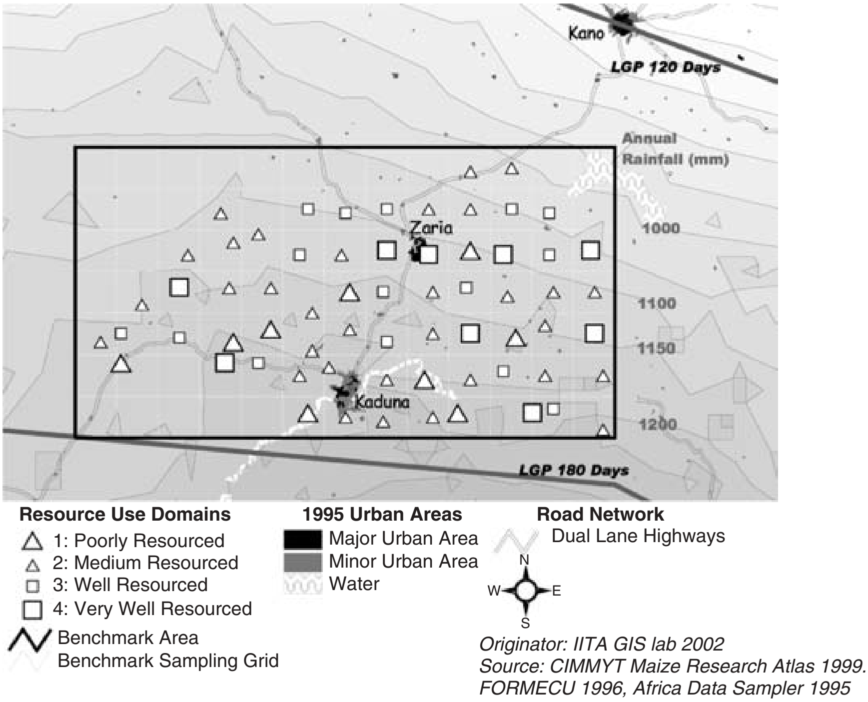

Figure 5. The Northern Guinea Savannah Benchmark Area.

co-authors on both publications. The macro-characterizations were important input into EPHTA.

After the launch of EPHTA (1995 to 2000)

Just prior to its official launch EPHTA delineated and characterized NGS benchmark area using a similar approach to that used for the FM benchmark area. However, rather than identify gradients, the subsequent multivariate analysis of the data identified four resource domains (Manyong *et al*., 1998) which were:

1. Low resource-use;
2. Low to medium resource-use;
3. Medium to high resource-use;
4. High resource-use.

Domain 1 represented the population expansion phase identified by Smith and Weber (1994) and Domain 4 represented the market intensification phase. Manyong *et al*. (1996a) found that just 1.1 % of the NGS was in the market expansion phase, so Domains 2 and 3 represent mainly subsets of the population intensification phase.

Figure 5 shows the 65 grid cells with symbols to represent the four resource-use domains. Manyong *et al*. (1998) suggested that the lack of the gradient in resource use was because the NGS benchmark area has no over-riding population gradient across it but instead contained within it several major urban centres and a relatively good road infrastructure linking them to their rural hinterlands.

The ASB forest margin benchmark area also became EPHTA's Forest Margins benchmark area. As with the FM benchmark area, selection of the research villages in the NGS benchmark area was guided by a mixture of results from multivariate analysis and pragmatism. First, the steering committee for the NGS benchmark area agreed to select three villages in each of the four resource-use domains to avoid farmers in any single village becoming overloaded with demands from researchers. The villages they chose were selected to be accessible from the Institute of Agricultural Research in Zaria in both the dry and wet seasons and on the basis of the number of people who joined the community interviews during surveying, as a proxy for interest in collaborating with researchers. Finally, the committee chose villages that would reflect the increasing north–south rainfall gradient (Manyong *et al*., 1998).

Characterizing the resource-use domains and choosing participating farmers

Once the research villages had been chosen, the next stage in the BAA was a much more detailed characterization at the household level. This work has been completed in the FM benchmark area (Gockowski and Baker, 1996, Gockowski *et al*., 1998). The analysis focused on household objectives and the process of intensification. Here principal components analysis was carried out on survey data from a census of 528 households in the six research villages and another ASB survey of 225 households in 15 villages across the FM. The analysis of the research village households identified two major livelihood strategies in the FM: the first was a land-extensive strategy with cocoa as the predominant cash crop associated with long fallow annual cropping systems, an abundant land endowment, relatively low wage employment, and the pursuit of hunting, fishing and wild food gathering. The second strategy was a land-intensive strategy characterized by commercial food production, particularly of horticultural commodities, livestock rearing, monoculture cropping systems, low wage employment and an abundant endowment of family labour. By cross tabulating these strategies, households were classified into four broad livelihood patterns, influenced by household endowments of land and labour:

- Resource-poor households with scarce land and labour endowments, pursing a subsistence agricultural strategy with a tendency to engage in off-farm employment and artisanal food processing;
- Land scarce but labour abundant households who sell much of their food crop production with a tendency for younger household heads to diversify into intensive horticultural production (see Gockowski and Ndoumbe 2004);
- Land abundant but labour scarce farmers whose livelihood strategies are founded on extensive cocoa agro-forests and other natural resource-based activities, such as hunting and fishing;
- More resource-endowed households with abundant amounts of both family labour and land resources, which are able to pursue income generating activities in both cocoa and commercial food production.

Having identified these patterns, the characterization team then carried out a more in-depth analysis of constraints and opportunities with the local communities to prioritize and guide future R&D interventions. For example, one key constraint for cocoa and horticultural enterprises is a lack of rural credit that often results in the neglect or abandonment of the activity after a calamity, such as an illness in the family, affects household finances. The constraint implies the need for research focused on the development of viable micro-credit schemes as well as profitable technologies that require lower capital investments.

The detailed village survey findings have other implications for research prioritization. The four groupings help in targeting the development of systems interventions congruent with the development trajectory identified in the characterization process. Secondly, the characterization will guide the scaling-up of innovations once successes have been demonstrated within the research villages.

The final step in setting up a benchmark area is to choose farmers to participate in field research. This is done on a case-by-case basis, depending on the problem being investigated and the interest of farmers themselves. The multivariate analysis has also been used as a guide for farmer selection in research activities where differences across classes are thought likely to influence the uptake of technologies. For instance, land scarce, labour abundant households pursuing commercial tomato production strategies in a peri-urban village of Yaoundé were identified and their participation solicited in an agronomic/economic evaluation of the use of peri-urban poultry manure on horticultural systems.

One obstacle to achieving greater impact with the BAA as implemented in the FM benchmark has been the incompatibility between the principal livelihood strategies pursued (cocoa and horticultural crops such as tomatoes) and IITA's mandate to improve soybeans, cowpeas, yams, maize, cassava and plantains. The first two crops are scarcely grown in this agro-ecology, while yams and maize are relatively minor crops, and cassava and plantains tend to be mainly grown for subsistence purposes with strong consumer preferences for existing varieties. Although the benchmark encompasses a major urban agglomeration of over 1.5 million people, the commercial production of IITA mandate crops largely occurs elsewhere. The lack of commercial incentives certainly has limited the generation of genetic, crop and resource management innovations for the mandate commodity production systems. One means of improving the BAA would be to a priori select the site on the basis of a well-specified priority issue that is congruent with the research institute's comparative advantage. In actual fact, the FM benchmark was chosen by ASB on the basis of the widespread practice of slash and burn agriculture and its primal importance in the deforestation of Cameroon (Essama and Gockowski 2001), and not because it is a region of dynamic change with regard to crops such as cassava and plantain.

Moving from characterization to impact

A question asked in the 2001 External Programme and Management Review of IITA was how the BAA would lead to improvements to farmers' livelihoods (CGIAR/TAC, 2001b). There are three reasons given by proponents of the BAA as to why we should expect it to succeed in having an impact on farmers' lives. First, the characterization process is based on a dynamic paradigm that is able to take account of change occurring in farming systems in response to the pressures felt by farmers. This allows research to be targeted to producing knowledge and technologies capable of solving problems that are faced by a broad range of farmers, and are thus more widely applicable. For example, one of the outcomes of the village-level characterization in the FM benchmark area has been a better understanding of the drivers of deforestation (Gockowski *et al*., 1998). One important reason identified as to why farmers cut down new forest is that they believe that plantain, an important crop to them, will grow well only in newly cleared forest. There is some basis for this: plantain needs good soil fertility, but that need is increased when nematodes attack and reduce the efficiency of the root system. IITA researchers are now demonstrating to farmers that it is possible to grow plantain on land that has already been cropped if the plantain rooting material is treated with hot water to kill the nematodes, and some fertilizer is added (Hauser, 2000).

Dynamic characterization can also identify high risk systems where farmers are likely to become receptive to change because of an impending collapse or crisis. It is in these areas where adoption and impact are most likely. Hence, dynamic characterization can also help in research priority setting.

The second reason why the BAA might be expected to benefit farmers is the idea that there may be villages in one location within a benchmark area that represent the future for villages somewhere else. Identifying these possible futures can guide farmers, researchers, and policy makers in making better choices about the technologies they select, the research they carry out, and the policy changes they attempt to bring about. Further, IITA has found that sharing this common concept, and concentrating research in a geographically defined area, brings about better integration between plant breeders, social scientists, and scientists working on NRM issues.

The third benefit the BAA brings, and perhaps the most important, is its potential to bring about scaling-up. Benchmark areas are supposed to be 'incubators' in which a critical mass of key research and extension stakeholders, NGOs, and IARCs work together with farmers to find and test solutions. In the process of working together, they set up knowledge networks. These are the channels through which people find out about new things, learn and exert influence. These knowledge networks link to policy makers at the village, local government, national government and regional levels, and this helps to create an enabling environment for these emergent solutions (see Figure 1). Characterization is a means to this end first by helping to bring key stakeholders together in the process of negotiating and delineating a representative benchmark area, and then in developing a database and a shared set of concepts that nurture and facilitate the incipient collaboration.

BAA impact

The FM benchmark area has been longest in operation and gives the best example of how the BAA has helped to build partnerships and to create international public goods. Some examples include:

- The process by which the FM benchmark area was selected together with stakeholders;
- The methods for choosing research villages representative of a larger resource-use domain;
- A model for understanding farmer decision making at the household and village level.

Good progress has also been made in building the partnerships necessary to create the key network-building international public goods needed for scaling-up. Staff working at IITA's Humid Forest Ecoregional Centre, from where IITA co-ordinates the FM benchmark, have been working to forge a broad-based research coalition that can address issues that no single organization can tackle. There are now four IARCs working in the FM Benchmark Area, as well as advanced research institutions such as Wageningen University, Johns Hopkins University, the University of Wales (Bangor), CIRAD, CABI, and various NGOs, farmer federations and government organizations, including IRAD. The Center for International Forestry Research (CIFOR), for example, is working on the adaptive co-management of forest resources which involves working with communities to identify preferred scenarios and helping to facilitate negotiation to achieve them. The World Agroforestry Centre is working on the domestication of forest tree species to help farmers establish productive and diverse agro-forestry systems. The World Fish Center is working to integrate fish farming into existing farmers' systems with the same potential impact of providing farmers with more options and more robust livelihoods. Delineation of the FM benchmark area and the characterization database has clearly facilitated these collaborative partnerships. The World Fish Center–IITA collaboration on aquaculture integrated with agriculture used the benchmark area characterization results to identify sub-divisional administrative units of differing resource-use and market access. The project is testing the influence of resource-use and market access on farmer uptake of innovations. Finding that urban market linkages were missing and inhibiting commercial incentives for expansion, the project is now developing an action research phase where collective marketing solutions in the Yaounde urban will be tested.

The benchmark area approach after the end of EPHTA

The EPHTA was never fully funded. It seems likely that the size and complexity of working in 11 countries with six benchmark areas and several smaller pilot sites dissuaded donors. IITA remained committed to EPHTA until the EPHTA co-ordinator was made redundant in October 2001 when IITA had a budget shortfall. In the same retrenchment programme the IITA co-ordinator of the derived coastal savannah benchmark area also lost his job. Nevertheless, some important champions of the Benchmark Area Approach remained and the approach continues to be used.

In some sense, IITA's research focus in the FM benchmark area, where cocoa is grown by over two-thirds of households, gave birth to the Sustainable Tree Crops Programme (STCP). STCP is a joint public–private partnership convened by IITA and funded by the chocolate industry, and various donors. Research on agricultural land use systems conducted in the FM benchmark area and elsewhere found that the shaded cocoa agro-forests were among the most sustainable cropping systems in West Africa and because of their multi-strata generated significant environmental services (Gockowski, *et al.*, 2004). STCP is now examining possibilities for scaling up these system innovations to other cocoa regions in Ghana and Cote d'Ivoire where systems tend to be much less diverse and less shaded (Gockowski *et al.*, 2004).

IITA's focus on the NGS benchmark area, underpinned by the BAA, helped spawn a number of donor-funded projects. These include a German-funded project on herbaceous legumes, a Belgian funded project on biological nitrogen management in soils and a British-funded project to control two weeds – *Striga hermonthica* and *Imperata cylindrica*. The new Forum for Agricultural Research in Africa (FARA) Challenge Programme, with a provisional budget of $25 million dollars over five years, has chosen the NGS benchmark area as one of its pilot learning sites.

DISCUSSION: EVALUATING THE BENCHMARK AREA APPROACH

In this section, we first evaluate the BAA by comparing it with the manifesto for good practice INRM that we developed previously. Good practice INRM is more of a wish list than anything concrete that has been achieved in practice. Hence, the IITA's BAA will achieve a good passing mark if it can at least show potential to fulfil the criteria listed below.

Against good practice INRM

Be able to blend 'soft' and 'hard' science. One challenge that confronts both the BAA and INRM is how to take 'soft' social and cultural factors into account in the relatively 'hard' biophysical and economic characterization so far carried out. This is important because, given that innovation and technological change are social processes, it follows that the adoption of a new technology is influenced by the cultural and social structure of the adopting community. This is clearly seen in the way that people with different cultural and ethnic roots will choose different farming systems and enterprises in the same resource domain. A good example is the preference of the Fulani people to be migrant pastoralists rather than farmers in northern Nigeria. Hence, characterization aimed at identifying which technologies are likely to be technical feasible, and the extension approaches that are needed to adapt them locally, must include information about cultural preference and attitudes to knowledge sharing and innovation.

An analogy can help in understanding this point. One of the key research tools used by plant breeders are experiments to test for genotype (G) by environment (E) interactions. In recent years, a third component has been added, which is farmer management (M), so the good practice is to test for G × E × M interaction. In IITA's BAA technologies (T) are developed and tested in different resource (R) use domains.

The assumption is that, just as with G × E experiments, understanding the nature of the T × R interaction will help in targeting the technology to suitable resource-use domains during scaling-out and scaling-up. The concept of a T × R interaction is captured in the five *attributes of a technology* (AT) that affect its adoptability, as identified by Rogers (2003) in his seminal book, *Diffusion of Innovations*. The five attributes are:

1. The relative advantage of a technology compared to what it is replacing;
2. The compatibility of the technology with existing systems and ways of doing things, which is closely related to culture;
3. The complexity of the technology in terms of what people need to learn to make it work;
4. The observability of a technology in terms of how easy it is to demonstrate and observe performance;
5. The trialability of a technology in terms of how easy it is to test it before deciding to adopt.

Another factor that affects adoption is the *learning process* (LP) that people engage in when experimenting and adopting new technology. For example, Douthwaite *et al*. (2001a) have shown that traditional 'spreading the message' type extension approaches, as used for improve germplasm, only work in simple systems and with simple technologies that virtually sell themselves. More complex technologies, introduced into more complex systems, need a co-development phase where researchers and first adopters improve the adoptability of the technology through iterative experiential learning cycles (Douthwaite *et al*., 2002). Two other factors also affect adoption. One is the *characteristics of the innovation system* (IS) doing the research, development and adoption in an area or region, including a benchmark area. At its simplest, an IS has three elements (Watts *et al*., 2003): (1) the groups of organizations and individuals involved in the generation, diffusion, adaptation and use of new knowledge; (2) the interactive learning that occurs when organizations engage in generation, diffusion, adaptation and use of new knowledge; and (3) the institutions that govern how these interactions and processes take place. The other factor is the *market* (M) for the technology, as this provides much of the motivation that drives the adoption process. Hence the adoption and impact of technology, i.e. its value as an international public good, depends on interaction and co-evolution between the four factors listed above, that is:

$$\text{Adoption and impact of a technology} = f(AT, LP, IS, M).$$

At present, the IITA BAA does not consider culture and ethnicity and this is a serious flaw. Nor does it attempt to identify and characterize innovation systems. Social network analysis (e.g. Cross and Parker, 2004) is an important tool in this respect. However, IITA is in an excellent position to carry out research on the interaction and co-evolution of technology attributes, learning process, innovation system and market because on-going activities in the research villages in the NGS and the FM benchmark areas can be treated as case studies of AT × LP × IS × M interactions. The insights from analysing these case studies can then help to design a characterization approach that can collect social and cultural data that can guide targeting of technology and extension process to a resource-use domain. This will be an important contribution to good practice FSR and INRM.

Acknowledge multiple stakeholders and multiple realities. Part of the rationale behind the BAA is to bring key stakeholders together to solve some of the complex research issues that no single organization can tackle on its own. The research and technology development is being done together with farmers in their fields. The BAA does, therefore, acknowledge multiple stakeholders.

The benchmark area steering committees were seen as the main mechanism for ensuring key stakeholder involvement. In practice, though, at least in the FM benchmark area, it has been found that a grouping of nine stakeholders, including farmers' organizations, a private sector seed company, international agricultural research centres (IARCs), non-government organizations (NGOs), universities, and extension services, is too large to decide on anything but the most general issues. Every stakeholder's point of view or buy-in is not needed on every issue. Specific problems and issues require their own, self-selected, stakeholder steering groups to guide them. Rather than communicate via a central benchmark area steering committee, these groups build their own information networks as need and opportunity present.

First solve problems locally. Problem solving in the benchmark areas is carried out in research villages and the solutions developed are thus specific to those locations. However, because these villages have been chosen to be representative of broad resource-use domains, then these solutions, together with the processes for socially constructing them during adoption in a new area, are more broadly applicable, and thus are international public goods.

Negotiate future scenarios with stakeholders. The work by CIFOR in the FM benchmark area is specifically about negotiating future scenarios. The agro-ecological modelling being carried out by IITA (Legg and Robiglio, 2001) has the specific objective of producing tools that will allow farmers, extension workers, and policymakers to see the effects of possible policy and other changes on land use and development patterns. This vision is the basis of stakeholders negotiating and deciding on their preferred scenarios and how to get there.

The work being carried out by the IITA Humid Forest Ecoregional Centre to demonstrate that it is technically and economically possible to grow plantain on already degraded soil, without having to cut down new forest, is giving farmers the option of a future with a forest nearby.

Social and experiential learning is central to research and extension efforts. The BAA uses a number of participatory approaches, which are all based on fostering and facilitating experiential and social learning. These include the use of the 'The problem census and problem solving approach' (Schulz, 2000) in some of IITA's work on *Striga*, and the 'Follow the Technology' approach (Douthwaite *et al.*, 2001b), which is guiding participatory technology development taking place in a project funded by the UK government that IITA is co-ordinating[3]. The ASB programme has adopted the participatory learning approach (Hagmann *et al*., 2000).

Characterization that helps change agents identify best bet technologies and processes, and facilitates scaling-up. Collinson and Lightfoot (2000, p. 393) have recognized IITA's work on dynamic characterization as 'an important step in the more insightful choice of technologies.' The processes surrounding the delineation of benchmark areas, the choice of research villages, and household-level characterization are all international public goods. This is because these methods facilitate communication and stakeholders negotiating common understandings. Due to their visual nature, maps showing the position and scope of different socio-economic and agro-ecological domains produced with the help of GIS, help in communicating at different stakeholder levels. Discussion of the information embedded in these maps helps to build knowledge networks amongst stakeholders working in the benchmark areas at different scales (see Figure 1).

We have already discussed how the BAA can help overcome current characterization limitation concerning the relationship: *adoption and impact of a technology = f(AT, LP, IS, M).* Once overcome, benchmark characterization, together with monitoring and evaluation of innovation processes, will allow change agents to identify best bet technologies matched to a particular resource-use domain and culture and then choose the appropriate learning process. Based on this information, change agents will be able to assess whether a conventional extension approach based on the delivery of simple messages and inputs will work, or whether a more expensive learning process is needed, for example a farmer field school.

Characterization could play another important role in the future. Holling *et al.* (2000) propose the adaptive cycle, from resilience theory, as a fundamental unit for understanding complex systems of people and nature. The adaptive cycle alternates between long periods of exploitation and conservation, when only incremental changes to a system are likely, and shorter periods of collapse, the release of stored capital, and then reorganization that create opportunities for much larger changes and major innovation. Characterization has a role to play in identifying systems that are in the release and reorganization phases because the opportunities for impact are much higher. Interventions during these phases should be aimed at enhancing resilience, that is, making the emergent system resilient to future shocks and changes (Walker, 2000). While the Smith and Weber characterization paradigm goes some way in this direction in identifying systems that are 'high risk', there is an opportunity to incorporate more of resilience thinking into the BAA and specifically into research prioritization. This would be another international public good.

Support the formation of knowledge networks. Characterization, and displaying that characterization through the use of GIS, is helping IITA to set up knowledge networks,

[3]'Realising sustainable weed management to reduce poverty and drudgery amongst small scale farmers in the west African Savannahh' Project, funded by the Department for International Development (DFID).

crucial for scaling-up, as we have already discussed in the last section. In the FM benchmark area, IITA's Humid Forest Ecoregional Centre is playing a facilitation role in forming knowledge networks by actively encouraging other organizations to join research efforts focused on the benchmark area. The Sustainable Tree Crops Programme, which the Humid Forest Ecoregional Centre is hosting for West and Central Africa, has a significant part of its focus in Cameroon within the FM benchmark area. The programme is working to increase the income of smallholder cocoa farmers through increased efficiencies in production, information sharing, and marketing, while generating environmental services. This effort has brought together diverse research groups in Cameroon and abroad, including local farmer groups, buyers, exporters, traders, processors and chocolate manufacturers. Links are now being established in the cocoa sector in Nigeria, Ghana and Ivory Coast. This network will permit the scaling-up of findings and experiences from southern Cameroon, as well as reciprocally from efforts of the other countries to Cameroon.

Consider causes and effects at different scales using the systems hierarchy concept. The idea of scale is integral to the benchmark concept as seen in the characterization process that begins at the scale of the agro-ecological zone and ends up at the scale of the farmer's field and the processes going on in that field. In an ASB modelling project being carried out in the FM benchmark area, models are being constructed at the village-level, based on individual households and fields (Legg and Robiglio, 2001). Results of modelling will then be aggregated by village, and extrapolated to the rest of the benchmark area based on topography, soils and market access, and on socioeconomic characteristics of other benchmark villages. At a later stage, a further extrapolation may be made to part or whole of the agro-ecological zone represented by the benchmark. For each extrapolation, considerations of scale and aggregation will be crucial, as will levels of information density.

Be practical and problem solving. The IITA's BAA has its roots grounded in farmers' fields, solving real problems. The focus on research villages ensures this. One example of the pragmatism and farmer-focus of the BAA is that the Humid Forest Ecoregional Centre is now working on mixed fruit and cocoa plantations, even though cocoa is not one of IITA's mandate crops. This happened because cocoa clearly came out as a main priority for farmers in the FM benchmark area. The recent collapse of the world cocoa price has created a need and an opportunity to intervene to help farmers build more diverse and resilient agro-forestry systems in the future. As a result of this farmer-centred approach, the Humid Forest Ecoregional Centre now hosts the Sustainable Tree Crops Programme that looks at linking tree-crop farmers and end-users to ensure farmer livelihoods through the empowerment of farmers groups, and the development of information systems and transparent market mechanisms.

Further, the use of participatory approaches, already mentioned, ensures that research efforts are aimed at tackling priority problems in practical ways.

Is the Benchmark Area Approach likely to bring sustainable, cost-effective benefits to farmers in complex systems over large areas?

The last section shows that the BAA and the activities now being carried out in the NGS and FM benchmark areas are a close match to best-practice INRM. We can therefore conclude that the BAA is more likely to bring sustainable, cost-effective benefits to farmers in complex systems than other possible approaches that are less well-founded on good practice. However, this is no guarantee that the BAA will make any important difference to farmers' lives on a wide scale. There is a concern (ISNAR, 2001) that while good characterization work has already been done, insufficient progress has been made in working with stakeholders and partners to build the knowledge networks and develop processes that are necessary for vertical scaling-up. As we have seen, the main rationale for the CGIAR system's ecoregional approaches is that these can produce international public goods that can facilitate scaling-up. It is important that the BAA quickly demonstrates that it can develop, in specific locations, useful technologies and the processes that allow them to be adapted and adopted more widely. This will then help in accelerating policy decisions to fund necessary changes to existing research and extension systems, away from top-down to more participatory approaches.

Lessons learnt

IITA's experience with EPTHA can give some useful guidelines to anyone wishing to carry out multi-site ecoregional research using benchmark areas. The reader will also be interested to compare and contrast these conclusions with those of the African Highland Initiative (AHI), another African ecoregional approach described in Box 1.

1. Move quickly to doing collaborative research with partners and stakeholders to develop both technical solutions and the processes for their development and scaling-up. The success of a BAA will be assessed primarily on whether it is able to set up and operate a 'working R&D continuum' amongst the stakeholders that develops technologies and the processes for scaling them up. Research to remove a 'bottleneck' in current best processes should proceed in parallel with the operation of the R&D continuum and not hold it up. Proceeding with imperfect approaches is better than not working towards making a difference to farmers' livelihoods.
2. Start simple and small with a maximum of just two benchmark areas. It took two years and two rounds of 15 country trips for the EPHTA co-ordinator to meet key NARES leaders before EPTHA was launched. Then the EPHTA proposal was not funded.
3. Build the BAA up from the bottom 'organically' rather than trying to impose an organizational blueprint from the top down.
4. Choose your benchmark sites in consideration of the key problems to be solved; a 'one size fits all' approach is likely to yield second best results.
5. Avoid large, unwieldy steering committees. While it is important to have a broad coalition of support at the beginning, this does not mean that every important stakeholder has to be involved in every decision. A horizontal structure where

smaller groups of stakeholders coalesce around areas of interest and communicate with each other and with other stakeholders works better than a more hierarchical structure where a central committee controls communication and access to higher institutional levels.

6. Do not get bogged down in trying to develop a common set of concepts and seeking for the perfect characterization paradigm. The participatory process of developing concepts and agreeing on delineation and characterization approaches is probably more important than the intellectual elegance of the result.
7. Ensure that culture and ethnicity are part of the characterization paradigm.
8. Promulgate an understanding of the dynamic nature of farming systems; encouraging natural scientists to see their research taking place in an evolving context, where changes are being driven primarily by socio-economic factors, helps focus research.
9. Make sure you have people with the necessary process skills to work in a collaborative and participatory manner with your stakeholders, from NARES to farmers. Seeing yourself as working as one actor in an innovation network requires a different mindset than seeing yourself as part of the 'centre of excellence' at the beginning of a technology research and transfer pipeline.
10. Make every effort to take others along with you, particularly people in your own institute. Keep a clear process paper trail so that people following after you can know the basis of decisions made.
11. Publish key concepts and approaches in peer-reviewed journals to show that your approach is sound. This will defend you against external criticism that might threaten the approach, as well as encouraging others to join in your collaborative effort.
12. Be flexible and learn as you go along. The INRM concept of adaptive management applies to this 'research on research' as well as to effective natural resource management by farmers. This paper represents part of the BAA learning cycle.

Box 1: Lessons learnt in the African Highlands Initiative

The African Highlands Initiative (AHI) is an ecoregional programme which seeks to develop and implement an integrated research and development agenda on natural resource management (NRM) at seven selected benchmark locations in four countries in East Africa: Kenya (1), Uganda (3), Tanzania (1), Ethiopia (2). As such, it is almost identical in intent to EPHTA in West Africa. AHI began in 1995, at about the same time as EPHTA. The difference is that AHI continues to be funded at the rate of $800 000 to $1 200 000 per year. AHI employs a co-ordinator, has a co-ordination unit and five research fellows who work regionally. About 50 % of the budget goes to national partners. Ann Stroud, the coordinator, identified some of the reasons for AHI's success and lessons learnt since it began (personal comment with Anne Stroud, 2004).

Success factors:

- Good facilitation and coordination. In particular, there is a need with such initiatives to better facilitate understanding amongst partners, in particular NARS, of the value of regional projects, and regional public goods. Without this understanding national directors of research will each want their own benchmark area and funding stream.
- An approach that has, from the start, involved consultation of all stakeholders involved, from the community to international scale (see Figure 1).
- A lot of effort put into capacity building from community up.
- Dedication and contribution of key people and donors (those interested in Participatory Action Research and ecoregional work).
- Working in benchmark areas that are small enough to be manageable.
- Producing results in the field and at the institutional level that are visible and readily explained.
- Motivated small team of regional researchers who try to meet often.
- Attention to process and strategy.
- A focus on helping people solve problems and exploit opportunities.

Lessons learned:

- Benchmark sites should be pilot learning sites where one experiments with different approaches and create 'models' to show to others and that can leverage bigger developments, as well as build capacity.
- A challenge is that participants in the AHI are under more pressure to carry out research than to write up results, train and disseminate the results. High staff turnover and lack of institutional memory adds to the challenge of capturing the knowledge generated as part of the AHI.

CONCLUSIONS

The IITA's BAA is a way of operationalizing INRM and ecoregional research by: (1) conducting research in a characterized benchmark area that contains within it farming system dynamics and a diversity that is representative of a portion of a wider agro-ecological zone; (2) developing 'best bet' innovations and processes; and, (3) building the knowledge networks amongst key stakeholders that are necessary for scaling-up.

Characterization, taking into account the 'dynamic nature of farming systems' and culture, is a critical component of a successful BAA. The process of characterization helps to bring key stakeholders together in the process of negotiating and delineating a representative benchmark area. Characterization provides databases and shared sets of concepts that help to bring farmers, key research and extension stakeholders together to work in partnership to find and test solutions. More important, however, is for this incipient network of actors to begin working together to develop technologies and processes for the different resource use domains and farming systems identified in the characterization. This helps satisfy existing donors through demonstration of impact, helps secure additional funding, creates demand for partnerships and builds NARES capacity. In the process of working together knowledge networks are formed with contacts to policy makers at the village, local government, national government, and regional levels, and this helps to create an enabling environment for these emergent solutions. Knowledge networks are the key to scaling-up; without scaling-up, NRM research will be localized and outside the mandate of CGIAR centres. Scaling-up processes are the main international public goods that ecoregional approaches need to be delivering.

IITA's experience in developing and implementing the BAA can provide useful lessons to other IARCs attempting to put INRM into practice. These include the need to start small and simple, to move quickly from characterization to building knowledge networks that will lead to scaling-up. It is these 'social' scaling-up processes, together with the 'technical' characterization processes and new technologies, which are the international public goods that INRM needs to produce to show it can produce to be truly successful.

An intellectual challenge facing the BAA is to develop characterization approaches that take into account the social and cultural factors known to influence the likelihood of adoption. If this is successful, then it should be possible to use GIS to match not just a technology that is likely to work in a new area, but the extension approach required to construct it socially. A second challenge is demonstrating that scaling-up occurs after the 'best bet' innovations and processes have been developed and knowledge networks have been built.

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