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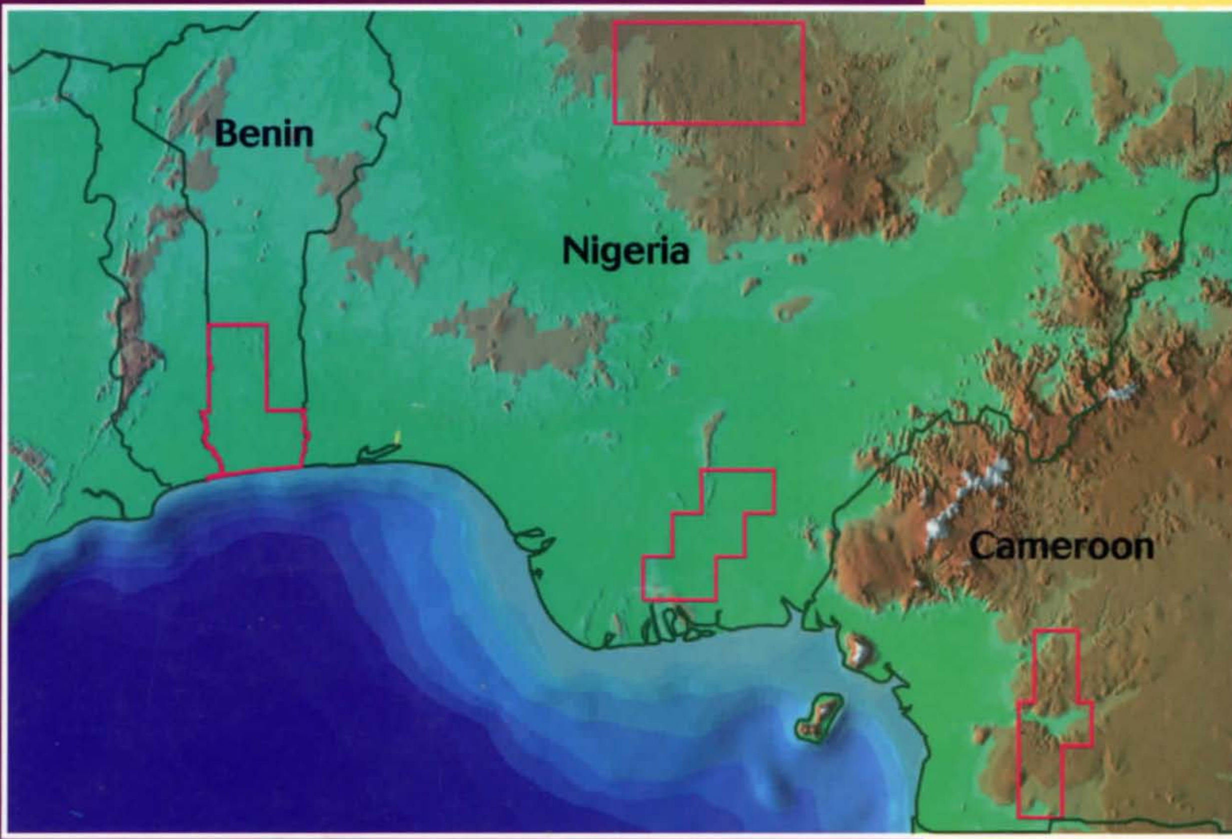
An impact assessment of IITA's benchmark area approach



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ISBN 978 131 192 4

Printed in Nigeria by IITA

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NB: This is a shortened version of the paper "IITA's Benchmark Area Approach: Putting INRM into practice" which has been accepted for publication in a journal special issue.

Abstract

Here we evaluate the IITA Benchmark Area Approach (BAA), which is being used to deliver general improvements to rural livelihoods in sub-Saharan Africa. The approach began evolving just nine years ago so a formal ex-post impact assessment is not yet appropriate. Hence, we evaluated the approach by comparing it against existing "best practice." We first established that existing "best practice" in developing sustainable improvements to complex agricultural systems is represented by integrated natural resource management (INRM) and current thinking in farming systems research (FSR). We then derived nine "best practice" criteria and evaluated the BAA against them, finding that the approach is delivering, or has the potential to deliver, on all nine. Hence the BAA is an important process innovation.

The IITA 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 diversity that are representative of a portion of a wider agroecological zone; (2) developing "best-bet" innovations and processes; and (3) developing the knowledge networks amongst key stakeholders that are necessary for scaling-out and scaling-up.

IITA's experience in developing and implementing the BAA can provide useful lessons to other international agricultural research centers attempting to put INRM into practice. These include the need to start small and simple and move quickly from characterization to building knowledge networks that will lead to scaling-up. It is these "social" scaling-up processes, in addition to the "technical" characterization processes, that are the international public goods INRM needs 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 geographic information systems (GISs) to match not just a technology that is likely to work in a new area, but the extension approach required to socially construct it. 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.

Key words: Benchmark Area Approach (BAA), integrated natural resource management (INRM), best practice, West and Centra Africa.

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 on 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 else are the problems more severe than in sub-Saharan Africa where population is expected to have increased by 132% by 2050 and where more than one-third of children are already underweight.

The Consultative Group on International Agricultural Research (CGIAR) helped catalyze the Green Revolution which sidestepped 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 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 IITA, based in Ibadan, Nigeria, and working 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 having a different set of resource endowments and constraints (Smith and Weber 1994). Consequently, IITA has been working for more than nine years to develop a different research paradigm, one that can be an effective catalyst for agricultural development in heterogeneous farming systems. The result is the Benchmark Area Approach (BAA) in which IITA works with a vertical consortium of stakeholders to address the whole research and development (R&D) continuum in a limited number of sites, strategically located to represent the diversity of agroecological zones in West Africa. The rationale is that this keeps IITA's research in touch with reality and demand-driven, while at the same time it builds 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 centers, must deal with NRM research issues in the longer term. Here we describe the BAA and evaluate the degree to which the approach is able, or is likely to be able, to help international agricultural research to catalyze a second Green Revolution.

Evaluation approach

Although the BAA has 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 could 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 best 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 "best practice," then the BAA is more likely to have widespread impact in farmers' fields than if it does not.

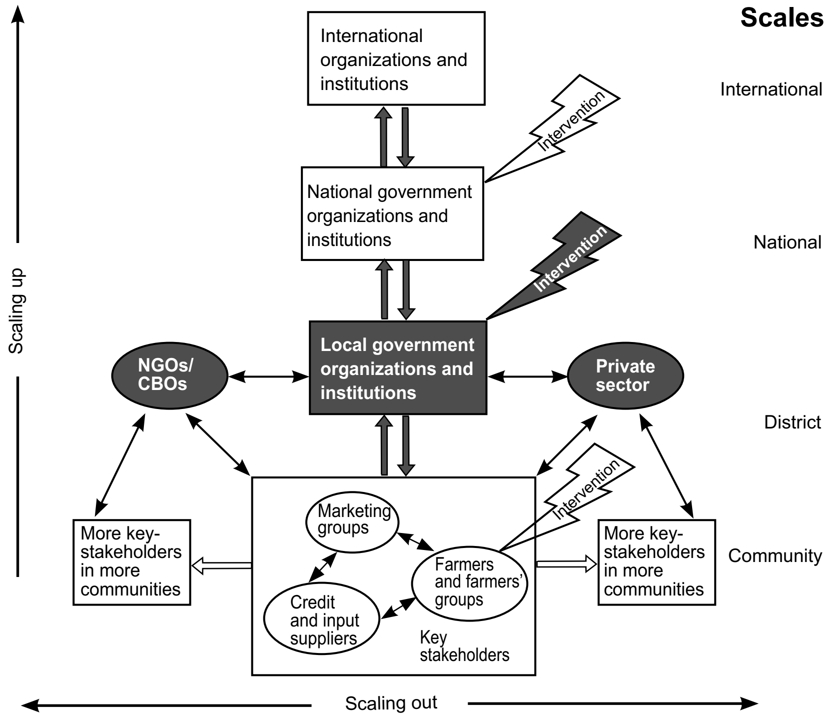
Establishing "best practice" in bringing sustainable, cost-effective benefits to farmers in complex systems

Integrated Natural Resource Management

The CGIAR system was set up in 1971, and consisted of 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 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 this evolution (CGIAR/TAC 1997). In 1998, the third external system review (CGIAR/TAC 1998) recommended that the CGIAR system set up a network to strengthen centers' ability to carry out INRM. This was a result of the recognition by the review panel that a paradigm shift had occurred in "best 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 "best practice" 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, nonlinear, and social process, while the "transfer of technology" approach sees it as a top-down, linear process, with end-users doing little more than deciding whether to adopt, or not to adopt.

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,



Note: CBO = community-based organization.
Source: Douthwaite et al. (in press), adapted from IIRR (2000)

Figure 1. Concepts of vertical and horizontal scaling-up.

in a few pilot sites. To justify international research investment, these technologies and the processes by which they were locally constructed 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 three 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 policymakers, donors, development institutions, and other stakeholders key to building an enabling environment for change.
3. Spatial scaling-up—the widening of the scale of operation from, for example, experimental plot, to field, to farm, to watershed, etc.

Scaling-out and scaling-up processes are illustrated graphically in Figure 1. Both are linked, because the further a change spreads 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.

"Best 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:

- Be able to blend together both “hard” and “soft” science in such a way as to be able to develop at the local level technical solutions and processes that work and are adopted, and then to scale these experiences up to the general level.
- 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.
- 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 Fig.1).
- Accept that problems must first be solved, and processes developed, at the local level before they can be scaled-out and -up.
- Support the central role of social and experiential learning though a number of tools, including monitoring and evaluation, based on commonly agreed indicators, and modeling future scenarios to support negotiation and decision making.
- Use characterization and GIS that help change agents to identify best-bet technologies and processes.
- Support the formation of knowledge networks built on a common set of concepts and databases that emerge from the characterization work. The knowledge networks are the basis for scaling-up and -out.
- Consider effects at different spatial and temporal scales using the systems hierarchy concept.
- Remain practical and problem-oriented—building researcher and resource-user partnerships requires researchers to come up with something useful in the first place.

The IITA Benchmark Area Approach

In this section, we examine the evolution of the BAA approach. In the next section, we compare the current BAA with the “best practice” criteria above.

The role of EPHTA

The BAA was the conceptual backbone and modus operandi of the now defunct Ecoregional Program for the Humid and Sub-humid Tropics of sub-Saharan Africa (EPHTA), one of seven ecoregional programs coordinated by CGIAR centers. Hence, for us to understand and evaluate the BAA we must first know something about EPHTA and the thinking behind ecoregional programs.

The drive for the CGIAR system to set up ecoregional programs 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 programs, CGIAR centers would not primarily be developing location-specific solutions but rather carrying out "research on research" to identify processes by which these solutions were developed and then scale up to benefit more people. If they were more widely applicable, then these technologies and processes would be true international public goods, to be used by NARES and others, exactly what the CGIAR system is mandated to produce.

Central to the ecoregional program concept were agroecological zones and the research sites within them. An agroecological 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 based on 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 policymakers to better target their technologies, research, and policy interventions (Collinson 2000).

EPHTA was one of the first ecoregional programs to be set up. It was officially launched in April 1996 after a 2-year preparation period during which the BAA that 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 program 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 agroecological and socioeconomic conditions found in the wider AEZ. This is because large benchmark areas would allow work on three important dimensions:

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

Process of choosing benchmark areas

After deciding 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 savanna 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.

Table 1 and Figure 2 show the benchmark areas eventually chosen. The moist savanna benchmark areas were delineated based on length of growing season (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 the humid forest AEZ and instead population density and degradation indicators were used. In Table 1, population pressure increases from forest margins to degraded forest while rainfall decreases from the northern Guinea savanna to the derived coastal savanna.

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 should be centered on a NARES station that could act as host. Southeast Nigeria was an obvious choice for the degraded forest benchmark area because it 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 savanna (NGS) and forest margin (FM) benchmark areas. Côte d'Ivoire and Ghana could both have hosted either a savanna or a forest benchmark area but, in the end, the countries negotiated that Côte d'Ivoire take a savanna site and Ghana should host a forest site. The remaining savanna site went to Bénin, partly because IITA had a station there and partly because of some good ongoing farm work including work on *Mucuna* (e.g., Versteeg et al. 1998).

Table 1. EPHTA benchmark area sites.

Benchmark areas	Country	Host institute
Moist savanna AEZ		
Northern Guinea savanna	Northwest Nigeria	Institute of Agricultural Research (IAR)
Southern Guinea savanna	Côte d'Ivoire	L'Institut des Savanes (IDESSA)
Derived coastal savanna	Bénin	L'Institut 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)

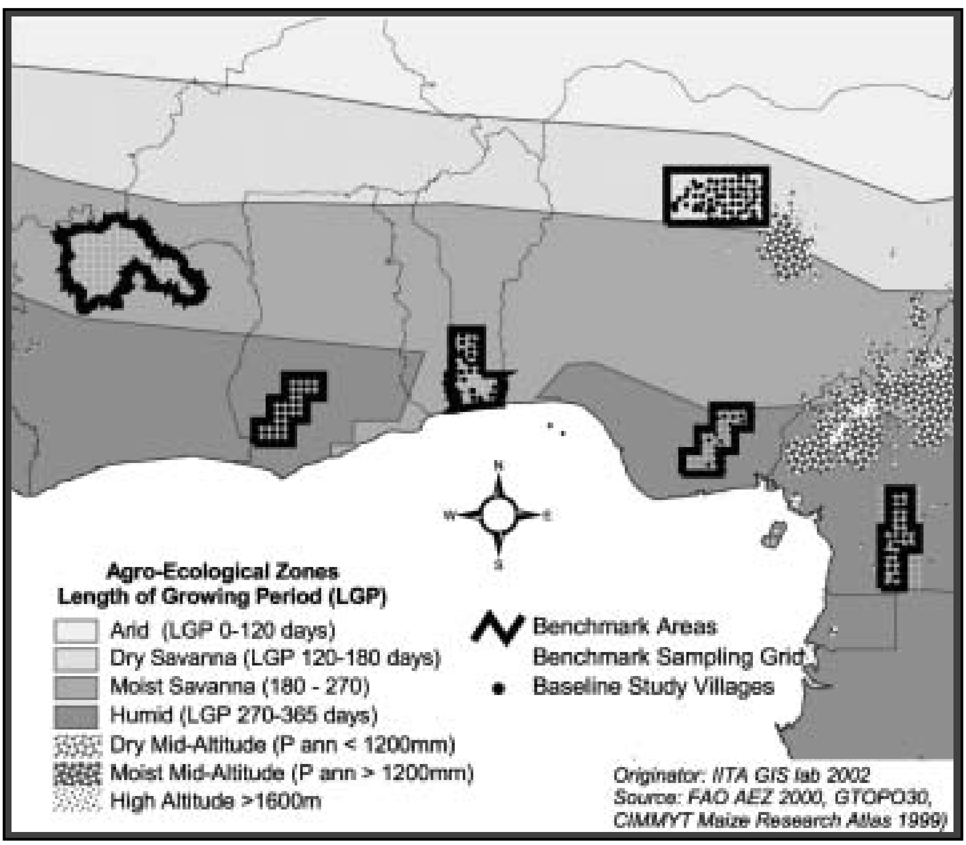


Figure 2. EPHTA Benchmark area sites in West and Central Africa.

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 by macrocharacterizations of West and Central Africa (Manyong et al. 1996a; 1996b).

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 2-year start-up period, the IITA-appointed EPHTA program coordinator 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 launching of EPHTA in April 1996 and agreed an action plan and a 5-year budget proposal. The action plan was remarkable in that all organizations committed real resources to EPHTA. Hence, EPHTA was able to function, albeit at a reduced capacity, even without full funding of the budget. The BAA continues to be implemented in the FM and NGS benchmark areas even after EPHTA came to an end in October 2001. Another remarkable feature of the work plan was the level of compromise to which organizations agreed in favor of partnership. For example, some countries agreed to give up benchmark sites in exchange for smaller pilot sites where technologies would also be tested as part of the scaling-up process. Unfortunately, though, because of funding problems, no pilot sites were set up.

Another example of negotiation was the agreement reached on initial EPHTA 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 recently submitted aspects of this work for the prestigious King Bedouin Award for 2002.

Governance of the benchmark areas was through steering committees that 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, with an average of nine stakeholders on each, including farmers' organizations, a private sector seed company, international agricultural research centers (IARCs), nongovernment organizations (NGOs), universities, and extension services. However, the committees do not meet regularly because of the lack of funding.

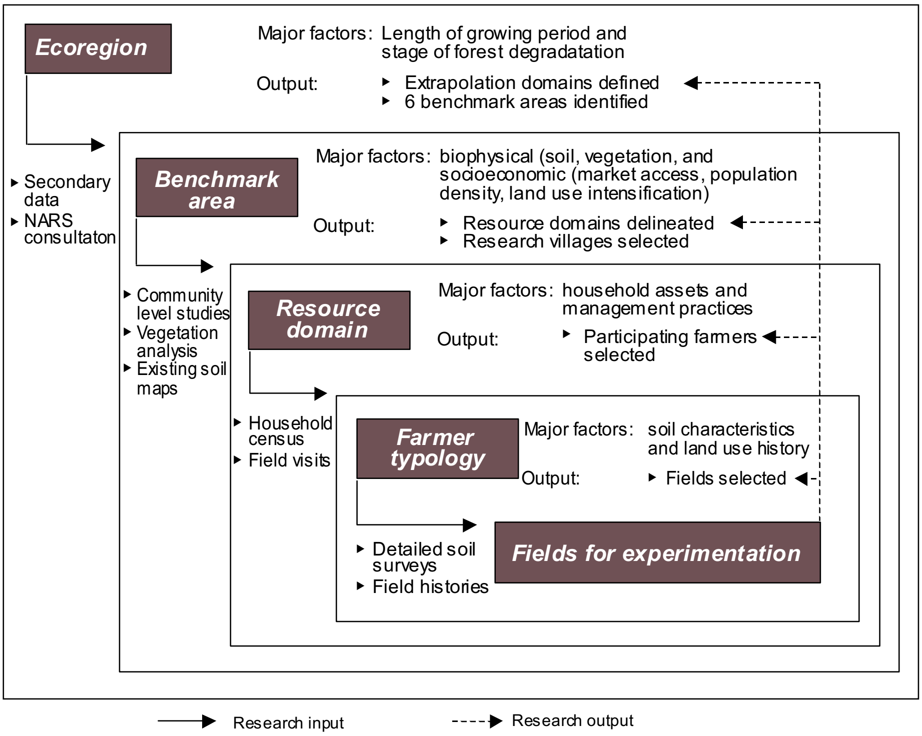
"Dynamic nature of farming systems" paradigm

Central to the whole BAA approach was that farmers' NRM practices and decision-making change over time, and these practices and changes can be correlated, at least at the macrolevel, by two sets of driving forces—those created by population pressure and those created by access to markets. Intellectually, this was very important because it had implications for scaling-up. It meant that while farmers' NRM decisions might appear to be location-specific at the farm or community level, when viewed from a more general level, patterns could be predicted by an analysis of population and market access 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).

Collinson and Lightfoot (2000) recognized IITA's dynamic paradigm as an important step forward. The dynamic paradigm built on work that showed that population pressure (Boserup 1965; Binswanger and McIntire 1987) and market access (Pingali et al. 1987) were the most important drivers because both motivate people to try and produce more from the land. However, rather than producing the same intensification process as others had assumed (e.g., Pingali et al. 1987) IITA's dynamic paradigm was built on the finding that they act independently. Smith and Weber (1994) noted that systems driven primarily by increasing population pressure start by expanding the area under cultivation. When no new land is available, an intensification period begins. This may occur either because there is no new land available or because farmers do not have access to it because of ownership issues. Either way, 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 labor fall in population-driven systems that are intensifying.

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 the 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 labor 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:



Source: Brader (1998)

Figure 3. Framework for benchmark area development.

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.

By coming up with these simple heuristics, Smith and Weber were very successful in communicating the dynamic paradigm to biological scientists. Evidence of this is that the terms were in nearly universal use in IITA, Ibadan, in the early 1990s and are still commonly used now (e.g., Okike et al. 2001). Indeed, one important benefit of the dynamic paradigm is that it provides a common set of concepts and principles that would allow scientists from different disciplines, backgrounds, and organizations to communicate and collaborate. This was seen as essential for EPHTA to work.

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.

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 noncrop income sources — More off-farm income — More salaried income compared to income from bush products and artisan activities

Evolution of the benchmark area characterization tool

IITA led the benchmark characterization work in EPHTA using a tool that evolved from work by Doyle Baker and Karen Dvorak as part of the National Cereal Research and Extension project (NCRE). This was a project of the US Agency for International Development (USAID)–Institute of Agricultural Research for Development (IRAD)–IITA in Cameroon. As part of the NRCE project's efforts to set priorities, Doyle Baker, who was Senior Economic Advisor to the Director of IRAD, and Karen Dvorak led a survey to characterize differences in natural resource management by farmers in the major ecological zones of Cameroon. Their approach was to use a survey tool derived from the hypothesized drivers of evolutionary change shown in Table 2, and then to identify resource use domains using multivariate analysis.

The NRCE sampling approach was to overlay an AEZ map of Cameroon with a 10 minute by 10 minute grid (343 km^2), randomly select 10% of the cells, and then send survey teams to conduct interviews in the village closest to the center of the selected cells. The survey began with village-level group meetings before

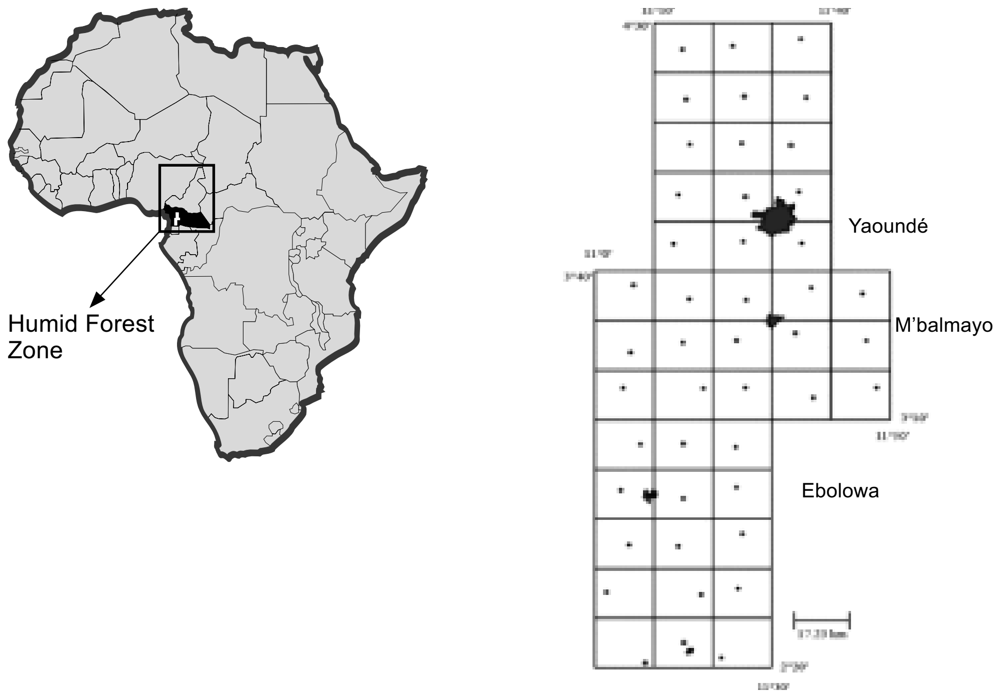


Figure 4. Forest margins (FM) benchmark area showing the 45 sampled grid cells.

breaking up into three groups to fill out a structured questionnaire based on the hypotheses encapsulated in Table 2.

In 1993, three years before the launching of EPHTA, the CGIAR launched the Alternatives to Slash and Burn (ASB) consortium, coordinated by the World Agroforestry Center. IITA and IRAD were nominated to coordinate a forest margins (FM) benchmark area in Cameroon and decided to build on the NCRE work. IITA and IRAD subsequently identified the benchmark area shown in Figure 4 that contained 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, an area of about 15 000 km^2, and was subdivided into three blocks of 15 cells each. Each block was felt to be relatively homogenous.

In 1993 and 1994, the 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 confirmed the intensification gradients and the similarities within blocks. The ASB group also used multivariate analysis to select two research villages in each block by determining the villages that were most representative of block traits. Villages with atypical soils, or which were inaccessible during the rainy season, were not considered.

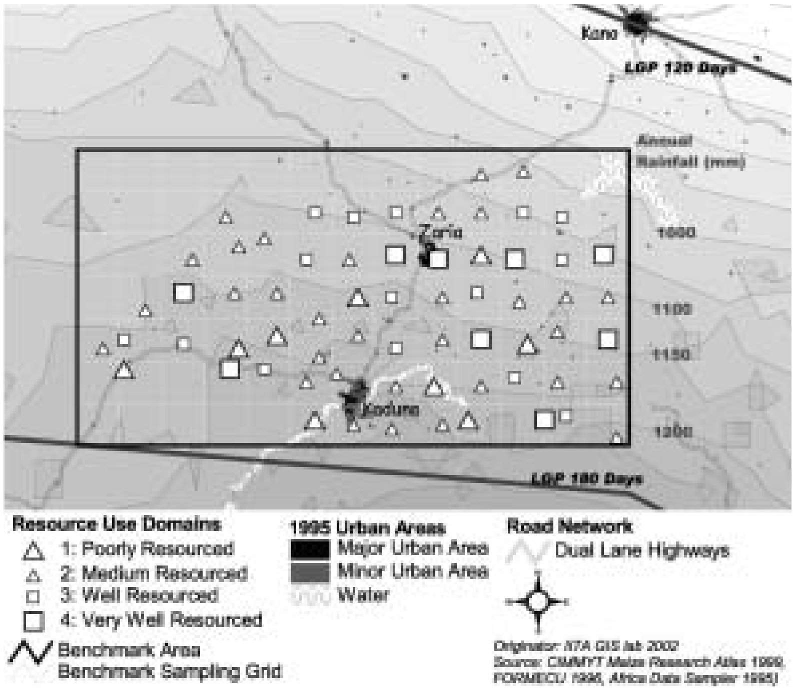


Figure 5. The northern Guinea savanna benchmark area.

When EPHTA began in 1996, the ASB forest margins benchmark area also became EPHTA's forest margins benchmark area and EPHTA also adopted and adapted the NCRE/ASB approach when it delineated other benchmark areas.

The EPHTA approach to identifying resource use domains in the benchmark

In 1995, prior to its official launching, EPHTA delineated the NGS benchmark together with NARES. The benchmark area, shown in Figure 5, covers an area of 65 contiguous 10 minute by 10 minute cells. It was characterized using a survey tool based on the one used in Cameroon, and the same method of sampling villages nearest the center of each cell.

The subsequent multivariate analysis of the data collected 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 shaded to represent the four resource use domains. It also shows an important difference between the two benchmark areas: whereas the three predetermined resource use domains are located along the population gradient in the FM/ASB benchmark area, in the NGS benchmark area the pattern is a patchwork. Manyong et al. (1998) suggested that this was because the NGS benchmark area had no overriding population gradient across it but instead contained within it several major urban centers and a relatively good road infrastructure linking them to their rural hinterlands.

As with the FM benchmark area, selection of the research villages 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 developing researcher "fatigue." The villages they chose were selected to be accessible from the Institute of Agricultural Research (IAR) in Zaria in both the dry and wet seasons. The number of people who joined the community interviews during surveying was 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

Having chosen the research villages, the next stage in the BAA, as shown in Figure 3, is a much more detailed characterization of each village, based on household interviews. This work has been completed in the FM benchmark area. Here multivariate analysis was carried out from census data from 528 households in the six research villages. The analysis identified four broad livelihood patterns influenced by household endowments of land and labor:

- Resource-poor households with scarce land or labor endowments, pursuing a subsistence agricultural strategy with a tendency to engage in off-farm employment.
- Land scarce but labor abundant households that sell much of their food crop production with a tendency for younger household heads to diversify into intensive horticultural production.
- Land abundant but labor scarce farmers whose livelihood strategies are founded on extensive cocoa agroforests and other natural resource-based activities, such as hunting and fishing.

- More resource-endowed households with abundant amounts of both family labor and land resources that 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, strikes 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. First, the four groupings help in targeting the development of systems interventions congruent with a dominant livelihood pattern. 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 the 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, labor 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.

Moving from characterization to impact

A question asked in a recent External Program and Management Review of IITA was how the BAA would lead to improvements to farmers' livelihoods (CGIAR/TAC 2001b). Three reasons are given by proponents of the BAA as to why we should expect the BAA to succeed in having an impact on farmers' lives. First, the characterization process is based on a dynamic paradigm that is better at understanding and taking 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 forest margins benchmark area has been a better understanding of the drivers of deforestation. 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 area within a benchmark area that represent the future for villages somewhere else. Identifying these possible futures can guide farmers, researchers, and policymakers 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 bring 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 in 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 with contacts to policymakers at the village, local government, national government, and regional levels, and this helps create an enabling environment for these emergent solutions (see Fig. 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.

Forest margins benchmark area

The FM benchmark area has been longest in operation and gives the best example of how the BAA has helped to build partnerships and is creating international public goods. Some examples of the scaling-out and scaling-up international public goods that characterization has produced or is producing are the following:

- 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.
- The methods for diagnosis and understanding of local farming systems.
- Although not yet finalized, a cost-effective approach to profiling the FM benchmark to identify wider areas in which technologies and policies will be relevant.

Good progress has also been made in building the partnerships necessary to create key network-building international public goods needed for scaling-up. Staff working at IITA's Humid Forest Ecoregional Center, from where IITA coordinates the FM benchmark, have been working to create 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, and various NGOs, farmer federations, and government organizations, including IRAD. The Center for International Forestry Research (CIFOR), for example, is working on the adaptive comanagement of forest resources which involves working with communities to identify preferred scenarios and helping to facilitate negotiation to achieve them. The World Agroforestry Center is working on the domestication of forest tree species to help farmers establish productive and diverse agroforestry 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 have clearly facilitated these collaborative partnerships. The World Fish Center–IITA collaboration on aquaculture integrated with agriculture used the benchmark area characterization results to identify subdivisional 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 aquaculture integrated with agriculture.

Evaluating the benchmark area approach

In this section, we first evaluate the BAA by comparing it with the manifesto for "best practice" INRM that we developed previously. "Best 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 satisfy the criteria listed below.

Against "best 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 community doing the adoption. This has important implications, for example, an extension approach that works in one community that has high homophily (meaning that the groups in the village are relatively homogenous and information flows easily) may well not work in a village with exactly the same socioeconomic and agroecological characteristics but where groups are much more closed and separate from each other (high heterophily). Therefore, characterization of innovative potential requires that data are collected on the key social factors that are likely to affect adoption processes.

An analogy can help in understanding this point. One of the key research tools used by plant breeders is 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 "best 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. But the process (P) by which a technology is introduced and adopted also matters. For example, Douthwaite et al. (2001a) have shown that traditional "spreading the message" type extension approaches, as used for Green Revolution technologies, can be expected to work only in simple systems and with simple technologies that virtually sell themselves. More complex technologies, introduced into more complex systems, need a codevelopment phase where researchers and first adopters improve the adoptability of the technology through iterative experiential learning cycles (Douthwaite et al. 2002). Hence, there is a T × R × P interaction and characterization needs to take this into account. Furthermore, the extension approaches matched to technology and resource use domain are exactly the international public goods that CGIAR centers need to be developing to justify their involvement in ecoregional approaches.

The IITA's BAA is in an excellent position to carry out research on the influence of technology type, resource use domain, and innovation process because ongoing activities in the research villages in the NGS and the FM benchmark areas can be treated as case studies of T × R × P interactions. The insights from analyzing 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 resource use domain. This will be an important contribution to "best 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 even nine different stakeholders 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, 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 agroecological modeling 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 visioning 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 Center 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 that 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 coordinating[1]. The ASB program has adopted the participatory extension 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 negotiate common understandings. GIS helps in this respect, particularly in communicating at different stakeholder levels, due to its visual nature. The knowledge and its communication help to build knowledge networks amongst stakeholders working in the benchmark areas from the research village scale, as shown in Figure 1, to the local government, national government, and regional levels as in the case, for instance, of the ASB project.

We have already discussed how the BAA can help overcome current characterization limitation concerning technology × resource use domain × adoption process interaction. Once limitations are overcome, benchmark characterization will allow change agents to identify best-bet technologies matched to

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[1] "Realising sustainable weed management to reduce poverty and drudgery amongst small-scale farmers in the West African Savanna" project, funded by the Department for International Development (DFID).

resource use domains and extension approach. For example, characterization should, in the future, allow change agents to choose whether a conventional extension approach based on the delivery of simple messages and inputs will work, or whether a more expensive farm field school approach is needed, or something in between.

Characterization could play another important role in the future. Holling et al. (2000) proposed 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 into thinking in the BAA and specifically into research prioritization. This would be another international public good.

Support the formation of knowledge networks

Characterization and GIS are helping IITA to set up knowledge networks, crucial for scaling-up, as we have already discussed in the last section. In the FM benchmark area, IITA's Humid Forest Ecoregional Center 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 Program, that the Humid Forest Ecoregional Center is hosting for West and Central Africa, has a significant part of its focus in Cameroon within the FM benchmark area. The program 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 Côte d'Ivoire. This network will permit the scaling-up of findings and experiences from southern Cameroon, as well as vice-versa, 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 agroecological zone and ends up at the scale of the farmer's field and the processes going on in that field, as shown in Figure 3. In an ASB modeling 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 modeling 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 agroecological 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 Center 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 resilient agroforestry systems in the future. As a result of this farmer-centered approach, the Humid Forest Ecoregional Center now hosts the Sustainable Tree Crops Program 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 a practical way.

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 "best 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 information 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. These 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.

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 are representative of a portion of a wider agroecological zone; (2) developing "best-bet" innovations and processes; and (3) building the knowledge networks amongst key stakeholders that are necessary for scaling-up.

Characterization, based on the "dynamic nature of farming systems" paradigm, is a critical component of the 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 and key research and extension stakeholders together to work in partnership to find and test solutions. In the process of working together, they set up knowledge networks with contacts to policymakers 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 keys to scaling-up; without scaling-up, NRM research will be localized and outside the mandate of CGIAR centers. 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. These "social" scaling-up processes, together with the "technical" characterization processes and new technologies, are the international public goods that INRM needs to produce to show that it can 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 socially construct it. 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.

List of abbreviations

AEZ	agroecological zone
BAA	Benchmark Area Approach
CGIAR	Consultative Group on International Agricultural Research
CIFOR	Center for International Forestry Research
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement
FAO	Food and Agriculture Organization of the United Nations
FM	forest margins
FSR	farming systems research
GIS	Geographic Information Systems
IITA	International Institute of Tropical Agriculture
INRM	integrated natural resource management
IRAD	Institute of Agricultural Research for Development
ISNAR	International Service for National Agricultural Research
LPG	length of growing period
NARES	national agricultural research and extension services
NRM	natural resource management
NGO	nongovernmental organization
NRCE	National Cereals Research and Extension project
NGS	northern Guinea savanna
R&D	research and development
TAC	Technical Advisory Committee

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About IITA

The International Institute of Tropical Agriculture (IITA) was founded in 1967 with a mandate for improving food production in the humid tropics and to develop sustainable production systems. It became the first African link in the worldwide network of agricultural research centers supported by the Consultative Group on International Agricultural Research (CGIAR).

IITA is governed by an international board of trustees and is staffed by scientists and other professionals from over 30 countries, and approximately 1300 support staff. Staff are located at the Ibadan campus, and also at stations in other parts of Nigeria, and in Bénin, Cameroon, Côte d'Ivoire, and Uganda. Others are located at work sites in several countries throughout sub-Saharan Africa.

IITA's mission is to enhance the food security, income, and well-being of resource-poor people in sub-Saharan Africa by conducting research and related activities to increase agricultural production, improve food systems, and sustainably manage natural resources, in partnership with national and international stakeholders.

IITA conducts research, germplasm conservation, training, and information exchange activities in partnership with regional bodies and national programs including universities, NGOs, and the private sector. The research agenda addresses crop improvement, plant health, and resource and crop management within a food systems framework, targeted at the identified needs of four major agroecological zones: the dry savanna, the moist savanna, the humid forest, and the midaltitude savanna. Research focuses on smallholder cropping and postharvest systems and on the following food crops: cassava, cowpea, maize, plantain and banana, soybean, and yam.

Cosponsored by the World Bank, the Food and Agriculture Organization of the United Nations (FAO), and International Fund for Agricultural Development (IFAD), the CGIAR is an informal association of over 40 governments and about 15 international organizations and private foundations. The CGIAR provides the main financial support for IITA and the 15 other Future Harvest centers around the world, whose collective goal is to improve food security, eradicate poverty, and protect the environment in developing countries.

This is one of a series of publications about the impact of IITA's work. The publications describe impact studies, conducted by multidisciplinary teams, which aim ultimately to confirm that IITA's research fulfils its mission to enhance the food security, income, and well-being of resource-poor people in sub-Saharan Africa.

IITA IMPACT

International Institute of Tropical Agriculture