

## **NATURAL RESOURCES MANAGEMENT RESEARCH IN THE CGIAR<sup>1</sup>: THE ROLE OF THE TECHNICAL ADVISORY COMMITTEE<sup>2</sup>**

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### SUMMARY

Judicious management of our natural resources is a major pillar of sustainable agriculture, broadly defined. It is, therefore, unfortunate that, until now, research in natural resources management (NRM) has not received sufficient support, or the recognition that other agricultural research topics have had. The Consultative Group on International Agricultural Research (CGIAR) recognized, early on, the complementarities and synergies between NRM research and other themes, notably genetic improvement, and its research Centres have pursued some vigorous programmes for many years. The Technical Advisory Committee (TAC) to the CGIAR was supportive of such programmes from the start and provided advice to the CGIAR System on NRM research strategies. Highlights of such advice over the last 20 years are discussed, including the ecoregional approach, the 1996 study of Priorities and Strategies for Soil and Water Research, and the CGIAR Vision and Strategy of 2000. Recent developments at the Centres leading to the promotion of integrated approaches to NRM (INRM) are described, and a set of priority areas in INRM research for future CGIAR activities is presented.

### INTRODUCTION

Through the 1960s, the Consultative Group of International Agricultural Research (CGIAR) focused almost exclusively on agricultural productivity and efficiency for its mandate crops. Even though emphasis was on genetic improvement aimed at

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<sup>1</sup> Created in 1971, the Consultative Group on International Agricultural Research (CGIAR) or the CGIAR System is an association of more than 50 public and private sector Members that support a System of 15 international agricultural research Centres. Membership includes developing and industrialized countries, private foundations, and regional and international organizations. World Bank, FAO, UNDP and IFAD serve as Co-sponsors. The CGIAR established a Technical Advisory Committee (TAC) in 1971 to advise the CGIAR on priorities and strategies, and monitor and evaluate the performance of the CGIAR supported Centres. TAC was transformed into an interim Science Council on 1 January 2002, and into Science Council on 1 January 2004.

<sup>2</sup> Based on the papers (TAC, 2001a and 2001b) prepared by the authors for and discussed by the CGIAR Technical Advisory Committee (TAC) in September 2001, CIFOR, Bogor, Indonesia. TAC (2001a) paper was also presented at the Workshop on Integrated Management for Sustainable Agriculture, Forestry and Fisheries, 28–31 August 2001, CIAT, Cali, Colombia.

yield increase, attention was also paid to pest and disease resistance, abiotic stress tolerance and general adaptability. Water-related research addressed primarily issues on distribution networks and on crop adaptation to water stress. This general approach was the sole focus, and continued as a central theme as new components were added in the 1980s.

Through the 1970s and 1980s, a cropping/farming systems approach was added to the research agenda, including research on optimum rotations and cover crops. In addition, work was started in the area of integrated pest management. Some programmes researched entire farming systems, including animal feed and other components. Others focused on the mandate crops 'in a farming systems context'. These efforts broadened the range of crops grown and their agronomic management. Varietal selection was often done, but genetic improvement was not included for those 'companion' crops. Farmer participatory methods became central to that work, as most was conducted on-farm, by farmers. Economic production research increasingly extended beyond individual crops to include systems impact on farm family incomes, labour use and food security. Water research emphasized water management and operations at the district level. Research on genetic improvement and on related agronomic practices continued for the mandate crops.

The concept of sustainability officially entered the Technical Advisory Committee (TAC) and the CGIAR in 1987, when sustainability and natural resource management concerns were identified as deserving high priority attention and the inclusion of the word 'sustainable' in the CGIAR goal statement was proposed (TAC, 1987). In 1988, TAC produced its first seminal work on sustainability and conservation and management of natural resources (TAC, 1988), which presented sustainability as a dynamic concept under the following definition: 'sustainable agriculture should involve the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources'.

#### THE 1989 CANBERRA MEETING AND THE ECOREGIONAL APPROACH

The CGIAR Mid-Term meeting at Canberra in May 1989 represented a watershed in the CGIAR in terms of initiating a broadened, more environmentally and natural resources management (NRM) focused mandate and set of activities. It was at this meeting that the proposal was accepted to add Centres dealing with forestry, agroforestry, water management, livestock and fisheries, broadening the focus beyond the crop improvement and the ecosystems that were being covered already.

In 1990, TAC reviewed a number of non-CGIAR, NRM-focused Centres (International Board for Soils Research and Management, IBSRAM; International Fertilizer Development Centre, IFDC; International Irrigation Management Institute, IIMI; International Council for Research on Agroforestry, ICRAF; International Centre for Living Aquatic Resource Management, ICLARM), and considered how best to add forestry to the System (TAC, 1990a). At the same time, TAC reviewed the weaknesses in CGIAR NRM research and the need to broaden the mandate

(TAC, 1990b). It was then that the ecoregional approach was first introduced as a means of combining geographically referenced agro-ecological considerations with land use, socioeconomic and policy considerations. At its annual meeting in October 1990, the CGIAR endorsed the concept of an ecoregional approach. This broadened the mandate beyond geographical areas delineated by commodity systems (e.g. upland rice, lowland rain-fed rice) to areas delineated by other (non-commodity) factors. However, boundary conditions were left unclear and there was need for further clarification.

In 1991, TAC further laid out the concepts underlying the ecoregional approach (TAC, 1991). In that report, a process for utilizing agro-ecologically characterized regions (including associated national land use and socioeconomic characteristics) as a basis for a revision of the CGIAR priorities and strategies was developed. The ecoregional approach also addressed two concerns: the strengthening of research on natural resources management and conservation; and the strengthening of National Agricultural Research Systems (NARS). The report (TAC, 1991) viewed the techniques used in crop production as tools for wider resource management. The components are shaped by criteria important to the productivity of the whole, noting the overriding importance of the human interaction with the land base, TAC considered that the formulation of a new integrated approach to resource management research was urgently needed.

The ecoregional approach was focused on a holistic perspective vital in the integration of components into appropriate technological solutions. Some past efforts to develop new resource management technologies had failed because the research was conducted on a disciplinary basis and did not take account of the socioeconomic environment of the target farmers. In this regard, another important dimension to TAC's proposed approach was the need to tie the research into the policy environment and so help push the pace of technology diffusion. In summary, three major considerations shaped the approach to resource management research:

- recognition of the need to marry the human and technical dimensions and address them in an integrated way;
- recognition of the need to adopt a system level approach and to plan and evaluate component research from this viewpoint;
- linkage of policy formulation as a key aspect of strategy.

Three key principles for the organization of ecoregional research were also recognized: systems approach; building multidisciplinary teams; and co-operation with NARS and the global commodity and subject matter centres. The ecoregional approach thus emerged as the way to integrate crop and natural resources research with the economic and social culture of specific regions (TAC, 1991; Gryseels and Kassam, 1994).

In 1992, TAC provided guidelines and targets for investments in NRM-related research through ecoregional and global programmes on genetic resources, water, fisheries, forestry/agro-forestry and livestock. In the mid-1990s, a number of activities took place that helped to define the current perspectives held in the CGIAR on Integrated Natural Resource Management (INRM). For example, two CGIAR-initiated

Task Forces were established: Sustainable Agriculture, chaired by Rudy Rabbinge (CGIAR, 1995a), and Ecoregional Approaches to Research, chaired by Cyrus N'Diritu (CGIAR, 1995b). Both task forces, and the resulting deliberations at the CGIAR Mid-Term meeting in May 1995 in Nairobi, helped shape future programmes and perspectives and to widen the network of linkages between the CGIAR and other groups working in INRM.

THE 1996 TAC STUDY ON PRIORITIES AND STRATEGIES FOR SOIL AND  
WATER RESEARCH IN THE CGIAR

In 1996, TAC led a study on 'Priorities and Strategies for Soil and Water Aspects of National Resources Management Research in the CGIAR' (TAC, 1996). This report (henceforth referred to as the 'S&W' study) made the first call for an 'integrated' approach to NRM, based first and foremost on soil and water resource management. We consider that the 1996 S&W study incorporated most of TAC's ideas that had evolved over the previous decade or so, and that it introduced many key ideas and concepts that form the basis for our current thinking. The TAC-recommended integrated approach to NRM research was laid out as follows:

*"... the CGIAR System could benefit from the introduction of a more consistent, systematic, and environmentally sensitive integrated natural resources management (INRM) framework for research. This framework would serve two main purposes. One is to provide a logical framework for linking the various natural resources management activities in the System. The other is to provide a better means of showing the rest of the world how the System is addressing the interrelated set of environmental and natural resources issues that are of concern when moving towards sustainable agricultural, forestry and fisheries production. Such a framework would involve four sets of interrelated linkages:*

- *Links between productivity-enhancing and resource conserving research (e.g. crop improvement and natural resources management).*
- *Spatial or landscape level linkages (e.g. upstream-downstream linkages in a watershed management framework).*
- *Temporal linkages (e.g. links between present and future, or sustainability considerations).*
- *Linkages between research and the diffusion / adoption of results from such research."*

The main conclusions and recommendations of the S&W study were as follows:

**Conclusion 1:** There is a need to improve the state of information on land and water degradation and its impacts on agricultural, forestry and fisheries production.

**Recommendation 1:** The CGIAR System should develop improved mechanism(s) by which Centres, collectively, can be involved with other partners in generating and interpreting improved scientific evidence on the extent and magnitude of the impacts of agriculture, forestry and fisheries on the degradation or enhancement of natural resources and the impacts of such degradation or enhancement on agriculture, forestry and fisheries production and food security.

**Conclusion 2:** The CGIAR System needs an Integrated Natural Resources Management (INRM) framework for research.

**Conclusion 3:** Within the INRM framework there is a need for an additional focus on specific subject matter.

TAC recognized back in 1996 that water was one area that particularly needed much greater emphasis within an INRM framework. It identified a number of issues

and challenges faced by agriculture, forestry and fisheries that were considered critical for food security. Thus, TAC concluded that water-related research was a priority area in which the System's scope and intensity of work should be significantly expanded to embrace the problem of water scarcity and competition among the different users. Emphasis was placed on sustainable resource use and conservation by addressing water quality issues and broad watershed management activities to complement the existing work on soil-plant-water relationships, allocation and distribution of irrigation water, and the role of water users associations and management schemes.

TAC also advocated a greater use of the interdisciplinary and systems approaches (including simulation models) in developing research within the INRM framework, and it suggested the need for the development of a limited number of carefully selected watershed or catchment studies that could serve as baseline studies or benchmark sites within the ecoregional approaches developed by Centres and their partners.

In the case of *temporal linkages*, the key area for research was the measurement of the rates of change in important dimensions of natural resources (the dynamics of resource management, use, enhancement and degradation); and the impacts of such changes on food and water security, and on health. The Report (TAC, 1996) also addressed the *linkages between research and diffusion/adoption* focusing on the long delays that existed between information development and generalized adoption including the reasons why existing information had not been used more effectively to improve natural resources management practices. It recommended research on how to get more effective implementation of existing knowledge for improved INRM, i.e. research on cultural diffusion and adoption of research results already available, as part of fostering a participatory approach to improving NRM.

**Recommendation 2:** Intensified and expanded collaborative mechanisms and activities should be developed among Centres, and between Centres and their non-CGIAR partners, to help focus increased research and institution strengthening on issues related to adoption, adaptation, and utilization of existing NRM technologies and knowledge that so far had remained unused.

**Conclusion 4:** There is a need for uniform and consistent criteria for judging the priorities for NRM activities/research in the CGIAR Centres and programmes.

TAC considered various criteria for assessing the relative importance of the proposals to strengthen or expand INRM research in the System. TAC recognized that the criteria or factors involved could also be used to look at the desirability for continuing current programmes.

TAC concluded that at least four factors, described in detail in the report (TAC, 1996), should be considered by those preparing proposals and in judging the relative importance of new research themes. More specifically, priority activities should:

- make an identifiable contribution to poverty alleviation and environmental protection or enhancement;
- be results-oriented and utilization focused (demand-driven with high probability of use);

- make optimum use of existing information and fill knowledge gaps;
- build on the CGIAR's international comparative advantages;
- have continuity of funding/support;
- consider ease with which acceptable lines of accountability can be established;
- propose standards of planning, monitoring and evaluation.

The above criteria for judging importance, and for choosing among operational modes, are fully consistent with those that have been adopted for use in the broader TAC Priorities and Strategies exercise related to Systemwide Initiatives and Programmes. They have evolved from TAC's experience in assessing future funding of the NRM components of Systemwide Initiatives and Programmes, including those based on the ecoregional approach.

The above conclusions and recommendations are probably as relevant today as they were in 1996 when the study was released. The CGIAR has made progress in alleviating some of the problems identified, and in taking advantage of some of the opportunities highlighted in the TAC study. Some areas of NRM information have improved markedly, although others remain in an unsatisfactory state. This is particularly so in the more complex areas that link the biophysical processes to the human/social processes that drive land degradation and natural resources use and misuse.

#### RECENT TAC THINKING AND ACTIVITIES RELATED TO INRM

In 1998–99, TAC introduced, and the CGIAR, accepted a logical framework ('the logframe') as a basic tool for organization and accountability of the System and its Centres. Within the context of the logframe reporting procedure, INRM was to be a part of production systems research for crops, trees, livestock and fish. This outlined the framework for conducting INRM research within the context of production systems, rather than as a separate entity within Centres or in a completely separate Centre or programme. It called for an output-based approach, with a need for impact assessment procedures to be put in place.

By the late 1990s, IIMI had changed its name to IWMI (International Water Management Institute), with a shift in focus and a broadening of mandate beyond the management of irrigation systems to include issues on watershed and river basin management up to the global scale. This represented a conceptual change which was increasingly demanded by changing global needs. More recently, the activities of IBSRAM were merged with IWMI to form a broad alliance, directed at conducting water research in a land and water conservation context.

In 1999, a TAC-sponsored external panel reported on a study of CGIAR activities and priorities for 'marginal lands'. (TAC, 1999a). This reviewed past efforts and assessed potentials and methods for research on marginal lands. TAC also led a study (TAC, 1999b) which concluded that the most successful programmes had been those with a clear focus on a major problem, strong leadership at the top, capable of articulating a vision of how a problem should be addressed, plus effective facilitation of collaboration at the research level. The report found that the principles

of the ecoregional approach had taken a firm hold in the CGIAR community and recommended that future work be conducted within a framework comprising three elements:

- research should be organized around major problems or opportunities for sustainable NRM that are of international relevance;
- it should use holistic systems approaches that combine human and technical elements to address the problems on multiple scales; and
- it should provide for its progress to be measured against specific performance indicators.

In parallel to TAC activities, researchers at the Centres had been discussing INRM research along similar lines. Also, there was a key event led by a coalition of researchers from different Centres: the Bilderberg (Netherlands) meeting in September 1999, organized by the inter-Centre Task Force on INRM under the sponsorship of the Centre Directors Committee on Sustainability and the Environment (CSE) (INRM-TF, 1999). Its outcome confirmed many of the concepts that had been evolving, and strengthened emphasis on some points, namely that:

- a formal group of researchers working on INRM in the CGIAR Centres was developed;
- an integrated approach to NRM was needed;
- the social component was as important as the biophysical one, and that it should be strengthened;
- increasing emphasis should be placed on identifying and including stakeholder groups; and
- the problem focus must be clear and specific in INRM activities.

In 2000, the CGIAR INRM Task Force had a follow-up meeting in Penang, Malaysia, to refine further CGIAR ideas related to INRM (INRM-TF, 2000). The meeting resulted in a strengthening and broadening of the CGIAR 'community of interest' group and a re-emphasis of the Bilderberg points of focus. Considerable attention was given to agro-ecology and ecosystem processes as ongoing concepts. Subsequently, two more meetings of this Task Force have taken place in Cali, Colombia (INRM-TF, 2001), and Aleppo, Syria, (INRM-TF, 2002) which have greatly contributed to the formulation of a common integrated vision on NRM research in the CGIAR.

#### THE CGIAR SYSTEM REVIEW PERSPECTIVE ON NRM RESEARCH

In 1999, the CGIAR System Review addressed the NRM research activities in the CGIAR in its Recommendation 5. It pointed to the emerging natural resource management methods as illustrating the paradigm shift in agricultural sciences: from classical agronomy to ecological sciences; from analytical research to systems dynamics; from top-down to participatory approaches; and from factor-oriented management to INRM.

The System Review recommended that the CGIAR should enhance its research methodology by adopting an INRM approach. Furthermore it proposed the organization of an International Network for Integrated Natural Resource Management research, and recommended that the Centres should be retooled with sciences needed to manage the viability and sustainability of ecosystems. Other recommendations included the adoption of precision farming techniques for tillage, irrigation, nutrient supply and pest and post-harvest management; the development of indicators for measuring sustainability and of systems for the sustainable management of aquatic resources.

The Centre Directors Committee (CDC) responded to the System Review's Recommendation 5 at the CGIAR Consultative Council meeting in Brussels in January 1999 by not endorsing the establishment of an additional network for INRM. The CDC, however, strongly supported the proposed conceptual framework and the need for increased support for ongoing INRM activities in the CGIAR. In response to the System Review, the CDC proposed an 'Action Plan' which had the following highlights:

1. The CDC believes that the CGIAR can best contribute to INRM and broader environmental objectives by strengthening ecoregional research capabilities and particularly by reinforcing inter-Centre co-operation at key benchmark locations.
2. The CDC proposes to strengthen its Committee on Sustainability and the Environment (CSE) by including Centre scientists who are leaders in INRM research. CSE will continue to be chaired by a Director General (DG), with additional DGs as members. It will take responsibility to assure the implementation of a strengthened INRM pillar in the CGIAR by the Centres.
3. The CDC recognizes that there are major gaps in the research coverage of current ecoregional programmes, e.g. measurement of carbon sequestration and greenhouse gas emission in many ecoregions. A gap analysis in the form of a matrix of systemwide and ecoregional environmental issues should be undertaken by CSE.
4. The CDC also recognizes that locally, nationally and internationally, resources tend to be spent on addressing symptoms of environmental degradation rather than understanding the underlying causes. We believe that a strong case can be made for donors to shift resources away from palliative 'environmental protection' and towards investments in research to understand the underlying cause of natural resource degradation.
5. The CDC proposes a number of immediate steps to strengthen INRM research in the CGIAR:
  - further studies of relationships between natural resource depletion and poverty;
  - case studies of the economic, social and environmental returns from INRM research;
  - better understanding of the relationships between natural resource depletion and both sectoral and extra-sectoral policies. For example, the impacts of agricultural policies on forests and fisheries; land degradation policies which focus on soil

erosion and ignore soil nutrient depletion, and soil fertility policies which focus exclusively on fertilizers;

- the need to bring INRM issues fully into the NARS agenda and to build NARS capacity in INRM research;
- the special need to strengthen INRM research in sub-Saharan Africa, where poverty and resource degradation are most acute;
- incorporation of appropriate climate change and biodiversity research issues in the research agendas of the CGIAR Centres.

TAC in turn reviewed the CDC response and associated Action Plan, presented at the March 1999 TAC meeting in Rome. TAC was in general agreement with the CDC positions and proposed Action Plan and offered to work with the CDC Committee on Sustainability and the Environment (CSE) and with the Centres towards implementing some of the lessons learned from previously reviewed programmes such as the ecoregional programmes. All the debates discussed above formed the basis for the viewpoints on NRM included in the CGIAR Vision and Strategy document prepared by TAC (2000).

#### NRM IN THE TAC DOCUMENT 'CGIAR VISION AND STRATEGY (2000)'

TAC recognized that poverty alleviation and sustainable food security for the rural and urban poor depended directly on the health of the environment and the sustainability of the natural resource base on which food, feed and fibre production depend, and therefore considered that conservation and enhancement of natural resources and protection of the environment should be central to the CGIAR core research agenda. However, to set the limits to how much and what type of NRM research the CGIAR should support, the following six principles were formulated (TAC, 2000) as the basis for setting priorities:

1. *The CGIAR should concentrate on NRM research that contributes to productivity enhancement and sustainability of natural resources for production of crop, livestock, forest and fish outputs that have impacts on poverty reduction and food security, giving appropriate consideration to inter-generational equity of benefits.*

Efforts should be made to create win-win situations and to minimize trade-offs between crop, livestock, forestry and fisheries production and environmental and natural resource protection.

2. *The CGIAR Centres should use an integrated NRM focus in their planning to define problems in NRM that require research.*

The INRM framework incorporates a broad spectrum of disciplines and activities, including those related to forestry, fisheries and genetic resources and describes a number of critical linkages.

3. *International integrated NRM research should be process oriented to ensure maximum contribution to production of international public goods.*

This principle applies to both biophysical and socioeconomic components, relationships and changes across environments, and the sociopolitical processes by which positive changes can be made or negative ones avoided. A number of examples were given (e.g. for water, forests, fisheries, livestock, soils).

4. *The CGIAR should give greater attention to research to resolve water issues.*

Irrigation currently uses two thirds of the developed water supplies worldwide and agriculture faces competing demands for water from all other sectors. Unless properly managed, lack of access to fresh water may well emerge as the key constraint to global food production.

5. *Focusing NRM research around common reference locations or benchmark sites is essential in incorporating the many dimensions of integrated NRM.*

This approach will provide a common environmental and problem set for multidisciplinary integration and interface with national programmers. The focal site (benchmark) work should be done within a Geographical Information Systems framework to facilitate extrapolation to the relevant recommendation or application domains.

6. *Priorities for specific NRM research themes should be determined by the CGIAR Centres in the context of the sustainability issues affecting productivity increases, regional priorities and comparative advantages of the CGIAR.*

As a nucleus for global knowledge on sustainable land and water management, the CGIAR could lead and coordinate global efforts to improve the state of knowledge on land and water degradation and its impacts on agricultural, forestry and fisheries production.

### TAC'S EVOLVING PERSPECTIVE ON INRM IN THE CGIAR<sup>3</sup>

#### *The context*

As evident from the discussion above, TAC's ideas on natural resources management research were evolving in keeping with new knowledge, with the changes in CGIAR objectives and with new thinking on issues such as sustainability and poverty alleviation. However, some points seem clear: while TAC fully acknowledged the multifaceted nature of the integrated management of natural resources, it also recognized and emphasized that the CGIAR cannot deal with all issues, challenges and opportunities. TAC's perspective of INRM focused on management of natural resources to achieve the goals of the CGIAR related to poverty reduction and sustainable food security. Nevertheless, it is important to bear in mind that the CGIAR

<sup>3</sup> It should be noted that following the CGIAR decision at its Annual General Meeting in October 2001, the Technical Advisory Committee ceased to exist on 31 December 2001, and was transformed into an interim Science Council with essentially the same tasks that TAC had. At the time that this paper was submitted for publication, the authors were working in the interim Science Council (iSC) that functioned in its advisory role to the CGIAR until September 2003. Our references to TAC after 31 December 2001 technically refer to the iSC.

is focused not only on NRM to help reduce existing poverty and food insecurity, but also on “*preventing future poverty and food insecurity by developing technologies that can help avoid future degradation of the natural resource base on which food, fibre, fuel and fodder production for the poor depends.*” While getting people out of existing poverty may have the most dramatic political visibility, preventing people from going into poverty because of declining food production due to environmental degradation is just as important from a humanitarian point of view.

It is possible to argue that most aspects of INRM are inter-related and that, in a sense, all INRM issues and opportunities should be of concern to the CGIAR, since ultimately, in one way or another, they relate to the goals of the CGIAR. While this is true in theory and in concept, it is also true that resources within the CGIAR are limited and that many more institutions of diverse nature and often with greater resources than the CGIAR are tackling many of the issues, relationships and research opportunities that exist in INRM. The CGIAR should focus on those INRM issues for which it has a comparative advantage, based on its many years of work in the agricultural systems of the developing world. At the same time, the CGIAR Centres should be, and are open to, co-operation and collaboration with many other groups involved in researching INRM problems that do not fall in the above category.

As pointed out in Harwood and Kassam (1993), TAC (and the interim Science Council), the Centre Directors Committee, the CGIAR Centres and the CGIAR investors have all co-operated during the 1990s and recent years to advance the intellectual and scientific base of natural resources management research for development. The ‘community of practice’ that has grown out of this co-operation has provided an atmosphere within which scientists, from both within and outside the System, have interacted to accelerate the evolution of NRM as a science applicable to the CGIAR and its partners. This provided the justification for the joint publication of INRM research case studies by the interim Science Council and Centre Directors Committee on INRM (Harwood and Kassam, 2003). The case studies reflect both the state-of-the-art in projects planned and organized during the 1990s, as well as their adjustments to incorporate the rapidly evolving fields of NRM science, and present a glimpse to a range of audiences of examples of INRM research problems, approaches and partnerships in action in the CGIAR.

#### *Assessing the impact of NRM research in the CGIAR*

The recent meta-evaluation of the CGIAR (World Bank, 2003) concluded that, although there are some notable accomplishments, on the whole the impacts of NRM research remain largely unevaluated, and that there is inadequate evidence of NRM impact. A proper measure of the impact of NRM research is essential to justify investments in this area. This is particularly difficult for a number of reasons, one of which is the attribution of research impacts. It has been generally accepted that the rate of return of the NRM research has been lower than that measured in other categories of research within the CGIAR, notably, that of genetic improvement (Evenson and Gollin, 2003). However, as Evans and Fischer (1999) pointed out, it is not possible

to separate the direct effects of genetic improvement on yield gains from the effects brought about by NRM research. When the assessment is carried out with scientific rigour, the contribution from the genetic component is less than what is normally assumed. For instance, in a study of the contribution of various components to yield gains of wheat in the Yaqui Valley of Mexico, Bell *et al.* (1995) attributed 28 % of the wheat productivity gains to genetic improvement, 48 % to N fertilizer and the rest to other undefined sources, partly related to NRM research. This statement and many others merely point out the urgent need to define better what is considered to be NRM and associated research.

Among the contributions of NRM research that are not captured in the traditional valuation methods are the conservation of soil and water resources, the reduction in economic and environmental risks, and the conservation of biodiversity. This is because some of these effects are diffuse and hard to characterize or because there are no markets for some of the services that are provided via improved management of the natural resource base (Harwood and Kassam, 2003). The challenge ahead is to devise methods and indicators that will permit us to monitor the progress made by INRM research on livelihoods and ecosystem goods and services. The Science Council of the CGIAR is currently undertaking this task, trying to learn more about the impacts of CGIAR NRM research and how to measure such impacts better (Kassam *et al.*, 2004).

#### *A set of priority areas for INRM research*

Within the context of what TAC believed were the appropriate boundaries for INRM activity within the CGIAR, focus was given to the following broad natural resource areas:

- integrated water and watershed management (i.e. management of land and water resources for the primary purpose of securing the best quantity and timing of water flows, and quality of water for the benefit of farmers and rural citizens, particularly the poor);
- management of water as a habitat for living aquatic resources for rural, coastal and floodplain (including estuarine) livelihood enhancement;
- management of land and terrain resources and related flora and fauna to enhance sustainable agricultural production, (e.g. prevention of soil nutrient depletion, declining physical properties of soils, when used under intensive and extensive agriculture);
- management of forest environments for rural livelihood enhancement, including social forestry as well as through the sale and personal consumption of forest outputs, including, but not limited to wild game, fruits, nuts, oils and other forest products;
- INRM associated with intensive peri-urban agriculture, livestock and renewable energy production through biomass;
- incentive systems for securing improved NRM management, e.g. through downstream land and water user payments to upstream land users for conservation

activities and through other means of bringing natural resources management into the market system.<sup>4</sup>

These issues or opportunity areas still remain the relevant ones and should be dealt with in an integrated fashion, within the four sets of linkages that TAC defined in its soil and water study and described above (TAC, 1996).

TAC also recognized, that ‘crossdisciplinary,’ ‘interdisciplinary’ or ‘multidisciplinary’ (whichever term is preferred) research is needed to deal with the six major NRM areas that are of concern to the CGIAR. It also recommends using both the biophysical and social science components required for a balanced approach to problem solving research. In this regard, TAC’s view of an integrated or multi-disciplinary research process is that:

- all relevant disciplines are brought together from the inception of the project and a research plan is developed under co-ordination;
- researchers in each discipline define the components of the overall issue which are relevant and addressable by them;
- researchers carry out the research in their own disciplines;
- researchers come together periodically to see how the pieces are fitting together and where gaps exist;
- finally, researchers and practitioners come together to present results and develop an INRM framework to respond to the issue or opportunity in question.

Obviously, using an INRM approach is not a guarantee for success and we have observed that, in some cases, more is promised from the integrated research model than actually can be delivered. Ultimately, good solid multidisciplinary research requires strong disciplinary input and effective coordination.

Additionally, scientific and technical developments, particularly in the information and communications technologies (ICT), are increasing our capabilities to carry out INRM research much more effectively, by extrapolating from point measurements to the larger scale in a realistic fashion. Furthermore, our understanding of the processes occurring at and beyond the field scale has increased substantially in recent years, thus providing new insights in to the behaviour of ecosystems.

At the same time, interdisciplinary approaches based on agricultural, forestry and fisheries ecosystem sciences such as production ecology, landscape ecology, water resources management, and integrated pest and biodiversity management show

<sup>4</sup> The CGIAR has a role to play in research related to securing poor farmers with payments for environmental services. This is evidently coming rapidly in the picture in many countries. Not only forestry, but also agroforestry, agriculture and livestock have roles to play. Payments which are a relatively modest source of income on a per hectare basis for developed country farmers may be significant contributions to income for poor farmers. There are important technological issues in which the CGIAR has been involved and could get more engaged, both to enhance the supply of services and to monitor delivery. An INRM focus would be useful since poor farmers need to design the delivery of environmental services as an integral element of their farming systems and livelihood strategies.

promise for being able to help integrate traditional disciplinary approaches and knowledge bases in more effective ways. To a large extent, the new technological developments in ICT are permitting this rapid progress.

COMPLEMENTARITIES: BRINGING THE PIECES TOGETHER IN A STRATEGIC,  
OPERATIONAL FRAMEWORK<sup>5</sup> FOR ACTION

Most of the elements essential to effective INRM programmes and projects are common to high quality research in any setting. But understanding the integrative nature of target ecosystem processes, and the regional nature of stakeholder problem identification and priority setting within them is a particular strength of Centre experience and programmes, which is reflected in outcomes from these recent meetings. TAC suggested a framework (Figure 1) to guide programme planning and structure as well as monitoring and evaluation. The details of most elements and processes will change with each programme and geographical area of application.

The framework for INRM/sustainable production projects or programmes has five elements, linked and integrated through a series of researcher/developer interactive processes:

1. Partnerships:

These are created, beginning at a local/regional level, and consist of stakeholder and partners in the research/development process. There is a growing CGIAR literature on roles and effectiveness of CGIAR partnerships, particularly with a regional focus (de Janvry and Kassam, 2004). Partnerships should begin at benchmark sites with farmer collaborators.

2. Scientific structure of the programme:

There are four components to the structure:

- Location and scale, which covers temporal dimensions, particularly for the natural resources components, and scale for both production systems and their natural resource base. Geographical scale must be built in at the design phase. It has scalar elements as shown in Figure 2, with function and partnerships changing at each level. The activities of CGIAR Centres are maximum with respect to those of other partners at the benchmark sites, where most of the field research is done as shown by the shaded areas at each level. Other partners have a much greater share of the work at other levels. The nature of the work changes at each level as well. Benchmark sites are chosen to provide key data prints along gradients of ecosystem or socioeconomic process and interaction. A site may be made up of multiple communities, watersheds or clusters of smaller units.

<sup>5</sup> Framework here is defined as a process with common elements of design, procedure and verification that applies to the fullest range of INRM project sizes and problem focal areas.

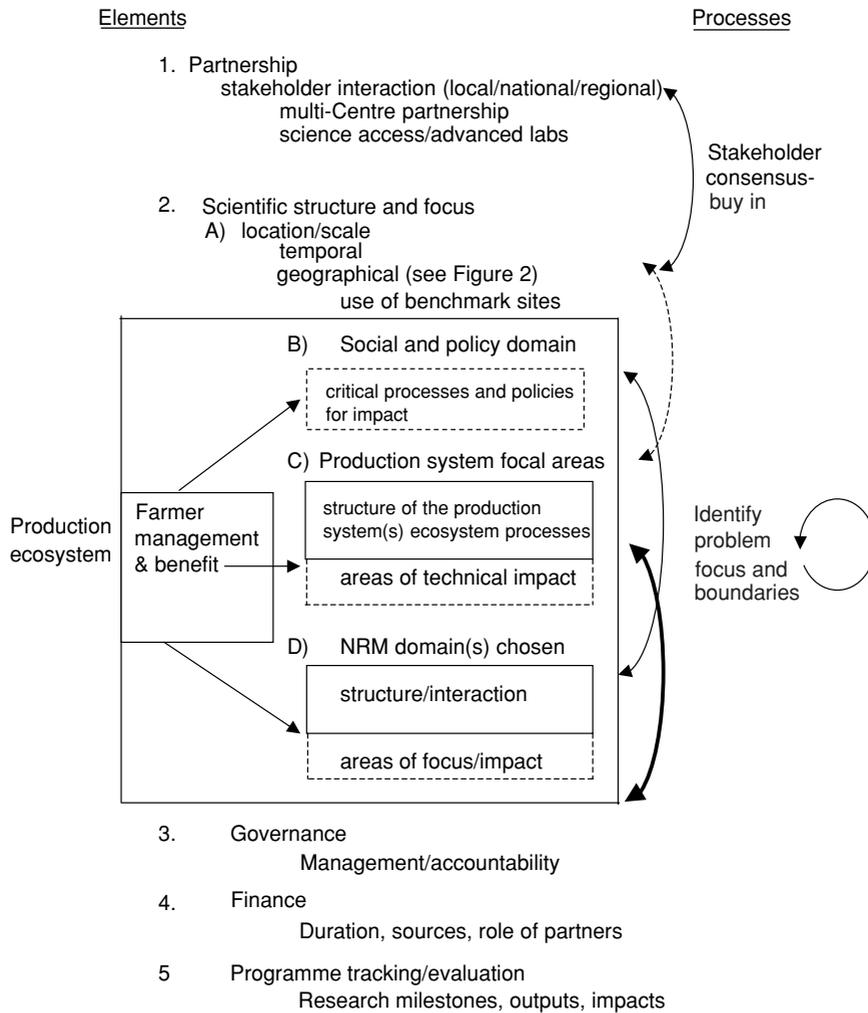


Figure 1. Framework for Programmes Sustainable Production Systems and INRM.

- Social and policy domains

All land and aquatic resource use systems operate within, and are highly governed by, social and policy environments. They should be outlined for each system, with critical elements which influence the production ecosystem targeted for attention.

Social interaction and public policy nearly always interact with and influence the biographical relationships between production system and natural resource status.

The process of programme integration through stakeholder and partner interaction to identify problem focal areas and their boundaries is critical to a programme’s scientific structure. Priority setting is a dynamic process, changing

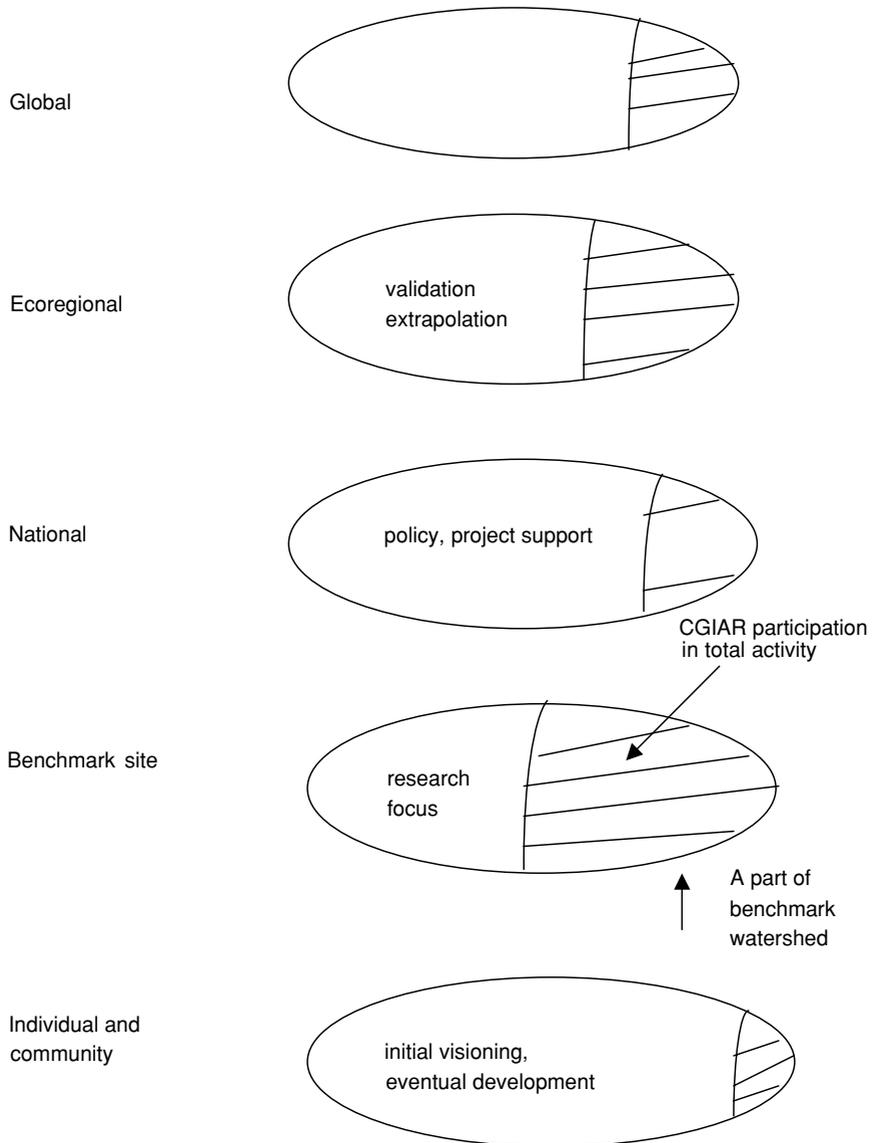


Figure 2. Functional activities and responsibilities at each level of scale. Source: Workshop on Integrated Management for Sustainable Agriculture, Forestry and Fisheries. Cali, Columbia, August 2001. Working group report on Frameworks.

with success, new opportunity and new problem occurrence. The farm family is both the manager and primary beneficiary of the production ecosystem.

- Production systems and their associated NRM domains are subsets of broader agroecosystems. Much of present INRM discussion centres around the characteristics, processes and components of these agroecosystems. Elements of biodiversity, resiliency and sustainability are fundamental at this level. Conceptual models derived in Penang (INRM-TF, 2000) pertain in particular to

crop-dominated agroecosystems. Those with major forestry, fisheries or livestock components may show differences. It is felt by agroecosystem scientists that most systems have from three to five 'drivers' of process that are continuous across gradients of environmental change, and which are key to their improvement and productivity.

Production system focal areas are chosen within the framework of integrated production systems. The focal areas must be elements of limiting technologies, and where CGIAR Centres have component technology expertise and advantage. They should be identifiable problem areas where there is reasonable scope for improvement.

- INRM domains

These are natural resource constraint areas for water, soils, biodiversity, or other resource limitations and problem focal areas. They occur within broad land/resource management systems (production systems). Any given resource will have interaction patterns with human management practices and production system type. A programme can start with either an NRM or a production system problem set.

3. Governance of the programme must reflect a local and regional priority setting and blending with stakeholder priorities up to the global level. Governance must be cost-effective and have clear responsibilities and lines of accountability. It must be dynamic, driven by both resources and scientific progress.
4. Financing must be for a reasonable duration and at a level consistent with programme objectives.
5. A process of programme tracking should follow the systems of logframe benchmarks and outputs. Impact expectations must be clear. Any programme must impact people's food security and their well being, in addition to having (usually) longer-term positive impacts on the resource base.

This framework contains elements essential to improving any sustainable production system or natural resource domain. TAC suggests it as an operational framework within which programmes evolve. The specifics of any production system and natural resource domain must be articulated at a regional level to be of any practical usefulness. The process of regional priority setting is as important as the eventual priorities chosen.

This suggested framework is an outline for programme structure. Nested within this are operational frameworks for the production ecosystem itself, and for each domain within it. These will change with each ecosystem type (e.g. aquatic, forest, watershed). The domain framework can occur at the component level, the operational level or at the level of underlying flows and processes. The programme structure framework suggested here is a general model that exists as a top-level, with structure, operational and process frameworks arrayed in descending order beneath it. The programme planner or evaluator must clearly understand this hierarchy and where each conceptual framework fits within it. Many of these models are spelled out in various reports coming

from the INRM meetings at Penang and Cali. The project component diagram only is presented here for clarity and simplicity.

#### CONCLUSION

The success and eventual impact on the lives of rural people, and on the resource base, will very much hinge on an appropriate and effective scientific structure and focus for the programme. It is a given that management processes must be appropriate and in place. The complexities of problem identification and scientific or technical solutions across gradients of change to achieve large-scale impact are not simple. The conceptual models must be relevant, limiting factors clearly understood, and priorities for change evolved through stakeholder involvement at relevant scales.

It is difficult to set a more specific model for INRM research. Regardless of which line of reasoning is followed, lessons from the past teach us that a key need is not to let the rhetoric of INRM get ahead of the science and not to focus too much on concepts without having common definitions and solid operational research approaches and procedures in mind. In the past, research on natural resources has been too often conducted in a disjointed, fragmented fashion. We have now reached a situation where problems in managing our natural resources are recognized to be multidimensional, with physical, economic, social and cultural dimensions. It is now possible, with the new conceptual advances in resource sciences and with the modern tools of ICT, to combine the various scientific and technological approaches to solving NRM problems with the social sciences to work towards the goals of poverty alleviation and of sustainable food security. That should be the main focus of the CGIAR in the area of INRM research.

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#### REFERENCES

- Bell, M. A., Fischer, R. A., Bryerlee, D. and Sayre, K. (1995). Genetic and agronomic contributions to yield gains: A case study for wheat. *Field Crops Research* 44:55–65.
- CGIAR (1995a). *Report of the Task Force on Sustainable Agriculture*. Washington, D.C.:World Bank.
- CGIAR (1995b). *Report of the Task Force on Ecoregional Approaches to Research*. Washington, D.C.:World Bank.
- Evans, L. T. and Fischer, R. A. (1999). Yield potential: Its definition, measurement and significance. *Crop Science* 39:1544–1551.
- de Janvry, A. and Kassam, A. H. (2004). Towards a regional approach to research for the CGIAR and its partners. *Experimental Agriculture* 40:159–178.
- Evenson, R. and Gollin, D. (2003). *Crop Variety Improvement and Its Effect on Productivity: The Impact of International Agricultural Research*. Wallingford, UK: CABI.
- Gryseels, G. and Kassam, A. H. (1994). Characterization and implementation of the ecoregional concept. *Invited paper presented at the International Food Policy Research Institute Ecoregional/2020 Vision Workshop, 7–9 November 1994, Virginia, USA*.
- Harwood, R. R. and Kassam, A. H. (Eds) (2003). *Research Towards Integrated Natural Resources Management: Examples of Research Problems, Approaches and Partnerships in Action in the CGIAR*. Interim Science Council and Centre Directors Committee on Integrated Natural resources Management. Rome: Food and Agriculture Organization.

- INRM-TF (1999). Integrated natural resources management research in the CGIAR. *Report on the 1st Integrated Natural Resources Management Workshop held in Bilderberg, Netherlands, 27–29 September 2000.*
- INRM-TF (2000). Integrated natural resources management research in the CGIAR. Approaches and lessons. *Report on the 2nd Integrated Natural Resources Management Workshop held in Penang, Malaysia, 21–25 August 2000.*
- INRM-TF (2001). Integrated management for sustainable agriculture, forestry and fisheries. *Report of the 3rd Integrated Natural Resources Management Workshop held at International Center for Tropical Agriculture, Cali, Colombia, 28–31 August 2001.*
- INRM-TF (2002). Putting INRM into Action. *Report of the 4th INRM Workshop held at ICARDA, Aleppo, Syria, 16–19 September 2002.*
- Kassam, A. H., Gregersen, H. M., Fereres, E., Javier, E. Q., Harwood, R. R., de Janvry, A. and Cernea, M. M. (2004). A framework for enhancing and guarding the relevance and quality of science: the case of the CGIAR. *Experimental Agriculture* 40:1–21.
- TAC (1987). *CGIAR Priorities and Future Strategies* (AGR/TAC:IAR/85). TAC Secretariat, FAO, Rome, Italy.
- TAC (1988). *Sustainable Agricultural Production: Implications for International Agricultural Research.* TAC Secretariat, FAO, Rome, Italy.
- TAC (1990a). *Role of the CGIAR in Natural Resources Conservation and Management: A desk study of the non-associated centres IBSRAM, IFDC, IIMI, ICRAF* (AGR/TAC:IAR/90/6 Rev.2). TAC Secretariat, FAO, Rome, Italy.
- TAC (1990b). *A Possible Expansion of the CGIAR* (AGR/TAC:IAR/90/24). TAC Secretariat, FAO, Rome, Italy.
- TAC (1991). *The Ecoregional Approach to Research in the CGIAR* (AGR/TAC:IAR/91/8). TAC Secretariat, FAO, Rome, Italy.
- TAC (1992). *Review of CGIAR Priorities and Strategies* (AGR/TAC:IAR/92/18.1). TAC Secretariat, FAO, Rome, Italy.
- TAC (1996). *Priorities and Strategies for Soil and Water Aspects of Natural Resources Management Research in the CGIAR* (AGR/TAC:IAR/96/2.1). TAC Secretariat, FAO, Rome, Italy.
- TAC (1997). *Review of CGIAR Priorities and Strategies* (AGR/TAC:IAR/96/6.1 and 6.2). TAC Secretariat, FAO, Rome, Italy.
- TAC (1999a). *CGIAR Research Priorities for Marginal Lands* (SDR/TAC:IAR/96/18.1). TAC Secretariat, FAO, Rome, Italy.
- TAC (1999b). *Review of Systemwide Programmes with an Ecoregional Approach* (SDR/TAC:IAR/99/8). TAC Secretariat, FAO, Rome, Italy.
- TAC (2000). *A Food Secure World for All: Towards a New Vision and Strategy for the CGIAR* (SDR/TAC:IAR/00/14.1/Rev.2). TAC Secretariat, FAO, Rome, Italy.
- TAC (2001a). *Evolution of NRM Concepts and Activities in the CGIAR* (SDR/TAC:IAR/01/18), FAO, Rome, Italy. Also, presented at the Workshop on Integrated Management for Sustainable Agriculture, Forestry and Fisheries, 28–31 August 2001, CIAT, Cali, Colombia.
- TAC (2001b). *Environmental Impacts of the CGIAR: An Initial Assessment* (SDR/TAC:IAR/01/11). TAC Secretariat, FAO, Rome, Italy.
- TAC (2001b). *NRM Research in the CGIAR: A Framework for Programme Design and Evaluation* (SDR/TAC:IAR/01/24 Rev.1). TAC Secretariat, FAO, Rome, Italy.
- World Bank (2003). The CGIAR at 31: An independent meta-evaluation of the Consultative Group on International Agricultural Research. *Operations Evaluation Department Report No. 25962. Washington, D.C.: World Bank.*