PART FIVE

Looking Forward

The expansion of the CGIAR mandate in 1990 to explicitly include sustainability, and in the mid-1990s to address poverty alleviation, raised issues of the scope and comparative advantage for IPG as well as approaches to INRM research and their linkages with impact. The Cases reported in Part III clearly show that the CGIAR Centres have made important progress in establishing frameworks for INRM research in the context of the CGIAR goals.

In the natural world of terrestrial and aquatic ecosystems, environmental functions and services are driven by the flow and exchange of solar energy, photosynthesis, and the carbon, hydrological and nutrient cycles. The deliberate use of ecosystems by mankind for the production of a large range of biological products for nutritional, social and commercial use alters the natural order and the associated ecosystem functions and services. For reasons of human needs and efficiency, outputs of biological products must be produced from large areas of altered terrestrial and aquatic ecosystems at productivity levels that are artificially enhanced several fold through the use of external and in situ supplies of germplasm, nutrients, water, biocides and management. Such altered man-made systems cannot sustain themselves unless they are deliberately managed with a sustainability goal by the users and beneficiaries. Also, the environmental functions and services of altered ecosystems cannot avoid the ecological- and biodiversity-related consequences or trade-offs caused by human interventions.

While the above is generally appreciated by the CGIAR Centres and their partners, the reality is that the management of natural resources by producers to give enhanced biological productivity for poverty reduction and sustainable food security is not just a question of getting the production technology right. It is also an economic, social, organizational, institutional and political issue, requiring an integrative holistic systems approach to research, in order to generate a full understanding of the altered ecosystem relationships and interactions, and their management for profitable social and economic use.

As seen in Parts II and III, the evolution of the INRM concepts and research in the CGIAR has essentially kept its focus on productivity- and environment-related issues. It has maintained a landscape- or watershed-based community and household approach, in which the macro and micro interests must be continuously monitored, and when necessary, reconciled. The dynamic nature of the relationship between rural communities, their livelihoods and resources has engendered a learning ethos in CGIAR research on INRM. This is partly because livelihood and environmental changes are noticeably measurable during the life span of research projects. Further, all the Cases have highlighted issues related to scaling up and out as being areas requiring further attention.

These four themes – productivity, landscape resources, livelihoods and scaling up and out – seem to define the areas where new or more effort must be focused. These are further elaborated in the following sections.

Productivity of biological goods and biophysical services

Productivity is a term much used by the CGIAR, which sees technology-driven improvements in biological productivity as a means of incrementally alleviating the income poverty of producers and consumers, and through it, social deprivation, as well as generating an accumulation of household, community and national assets. Where biological products are marketable, productivity improvements can have a direct effect on income and poverty alleviation, because the increase in productivity leads to more efficient production due to better factor productivities, thus improving competitiveness at the production as well as the consumer end. Most studies measure changes in productivity in terms of yield per hectare, and sometimes in other partial factor productivity indicators, but only rarely do they provide changes in total factor productivities.

A proper measurement of the productivity of INRM practices is essential for understanding the efficiency and competitiveness of resource use for biological production. However, partial factor productivity measures can be misleading if considerable input substitutions occur, and they also mask many other factors accounting for observed productivity differentials (Ehui and Jabbar 2002). Some have argued that a conceptually superior way to estimate productivity is through total factor productivity, a ratio of aggregate output to aggregate inputs used in the production process. However, logic would suggest that both partial and total factor productivities are meaningful measures, particularly when the aim is to understand the nature of change at the most disaggregated levels, so that substitutions and trade-offs can be recognized and quantified. Without productivity measures, values cannot be assigned to the contributing factors or to the resource balances in the system. Further, the productivity of integrated production systems in which benefits flow across production components, as seen in most of the Cases, are difficult to quantify because of methodological problems.

It is not always clear from the Cases presented how much fresh thinking is ensuing on how best to measure biological productivity of goods in INRM research at the various scales from plot to farming system to agro-ecosystem.

The situation is far more complex when dealing with the productivity of ecosystem services – geobiophysical and environmental. Ecosystem services to society such as maintenance of biodiversity including soil biota, control of pests and pathogens, life support services, the maintenance of local environmental quality through water, carbon and nutrient stocks, cycles and flows, removal of pollutants from air and water, and the control of erosion are increasingly being recognized. CGIAR's interests lie in the fact that such services have to be performed in and by altered ecosystems, because agricultural land use modifies the ecosystems for biological production, as shown in Cases 1, 2 and 3 where erosion control is targeted. However, these services and their productivity measures have not been fully explored to a point where changes in the ecosystem or agro-ecosystem integrity or health can be assessed. Thus it is not possible to determine what is actually happening in terms of adjustments to new ecosystem states, and to estimate any temporary or longer-term trade-offs. The Cases in Part III show that there is a need to make a serious move into this area of research, so that environmental services can be accorded economic value recognized by markets, or for which society is willing to compensate those who influence such services through their engagement in INRM.

Some progress has been made in the area of carbon sequestration, a service increasingly sought after, and whose marketable potential appears to be increasing in importance. Some work has been done to quantify net ecosystem or net biome productivity, to clarify the underlying concepts, and to focus on the ecosystem processes that determine whether an ecosystem is accumulating or releasing carbon. However, in terms of poverty alleviation and sustainability, answers are needed at the plot level as well as at larger scales, so that economic benefits can be directed to those who can offer carbon sequestration services. Currently, the crude measure of economic productivity is the GDP indicator, but this does not take into account the value of environmental services or quality of life functions and services. The overall aim of successful INRM research must remain the development of INRM science and technology that will improve the capacity of ecosystems to deliver biological goods and environmental services needed for poverty alleviation, sustainable food security and well-being. It is thus important that indicators representing ecosystem service productivity and health are developed as part of INRM research by the CGIAR and its partners.

Landscape and watershed resources for poverty alleviation

As stated earlier, human interventions affect all ecosystems to some degree, and man-induced changes in resource use and ecosystem processes this century have been unprecedented (McNeill 2001). It is important that this is understood in ecological terms as well as social and economic terms. The science of agro-ecosystem functioning is the key to understanding the economic value accorded to ecosystem resources. Unfortunately, there is always a lack of baseline information necessary to determine ecosystems' resources and their condition at most levels, including that at a local scale. Also, there is a lack of systematic approaches to integrate analyses undertaken at different locations, and at various spatial and temporal scales (Wood *et al.* 2000). Further, where trade-offs are involved, it has been difficult to assess if there are threshold levels being undermined or exceeded. The following two areas deserve greater attention from INRM research in the future.

Valuation of resources: Individual households, communities and larger societal groupings all derive livelihoods, develop wealth and accumulate assets, and achieve higher levels of social and economic development

through the exploitation of a range of renewable and non-renewable resources. But to successfully exploit resources for goods and services desired by social groups or their governments requires intellectual, organizational and managerial skills to build social, man made and human capital that can ensure that the benefits accruing from exploitation will lead to improvements in human well-being. In the exploitation process, some natural capital resources are used, or even sacrificed in the case of non-renewable resources, in order to build new man-made human and physical capital assets and social services. Where market forces operate, a valuation may be possible, but markets often fail to recognize the full value of a particular natural resource. So far, it has not been possible to assign values to the different natural resources in a landscape or a watershed exploited by a social group. There was an attempt by the World Bank (Serageldin and Steer 1998; World Bank 1998) to conceptualize the problem of resource valuation at the national level, in order to assess the "greenness of the national accounts". This work showed it was possible to assign values to the different national resources in comparable terms, and to monitor annual changes in the value of, and benefits from, the different resources. The concept of sustainable livelihoods at the household level has similarities to the World Bank "greening" concept, but again its full value in INRM science will depend on the development of measures and methods for assigning values to the different capital assets at household and community levels.

Valuation of negative impacts of resource use: In the light of what has been stated earlier, it is not surprising that INRM research has been unable to quantify the full value of the negative impacts from deriving resource use or even abuse. While some of the Cases make an attempt in this direction, the trade-offs involved are not captured fully. The notion that there are always win-win INRM opportunities is not supported by scientific observations or experience. More attention must be paid to situations where communities must cope with local win-loss situations within overall win-win situations, as more sophisticated INRM practices need to be managed at higher levels of organizational integration. Cases 2 and 5 suggest that some INRM work is already moving in this direction, but more is necessary.

Sustainable livelihoods

Two aspects of livelihoods, in particular, appear to offer opportunity for further improvements in INRM research. These are: the link to poverty, and impact assessment.

Link to poverty: Poverty alleviation in the longer-run is more than earning income beyond the poverty line. It must be accompanied by the accumulation and acquisition of assets at the household and community levels, which must be managed sustainably and profitably, as elaborated and incorporated in INRM research in the CGIAR. Thus, rural livelihoods and their future at the local community level are defined partly by access to tangible assets, e.g., natural, physical and man-made, to non-tangible assets, such as social and liquid assets (e.g., financial), and partly by the higher order national and international forces and opportunities of social, economic and infrastructure development lifting communities into a higher level of economic and political integration. The linkage between INRM and poverty reduction will therefore vary depending on the actual mix of livelihood assets and opportunities.

Most of the Cases in Part III reflect the appreciation that INRM research must address the concerns of sustainable livelihoods as determined by their overall multilevel condition. This is no better captured than in Case 5, in which the approach facilitates the integration of research on policy, property rights and the institutional and socioeconomic environment, so that issues are addressed from a technical, socioeconomic, cultural, institutional and policy perspective. It is proper that INRM approaches

are incorporating sustainable livelihood concepts in their analysis, but the aim must be to change the asset profile of households to enable poverty reduction to occur at household and community levels. While technology for productivity improvement is an essential precondition for change, it is not a sufficient condition. INRM aimed at poverty reduction must enter the social and cultural fabric of the household and the community in which the economic activities of farms are embedded (Cernea and Guggenheim 1985).

The direct and indirect links between INRM and poverty have not been adequately researched. Given the multidimensional and heterogenous nature of the linkage, there appears to be a need for more sophisticated modelling approaches to describe the nature of the key linkages, including those related to productivity, risk reduction, income, employment and asset formation.

Impact assessment: Most studies show that the rate of return to NRM research is significantly lower compared with other categories of research. It is equally becoming clear that the problem is more to do with attribution, and sometimes with valuation. Alain de Janvry, in a private communication with the editors, explained the problem as follows. To convert improvements in genetic productivity into biological output requires the complementary enabling INRM production factor inputs and practices. For example, NRM is well known as an input for efficiency and productivity gains contributing to yield increases and to quality improvements of foods, but it also contributes to other biological products, e.g., on-farm water harvesting and on-farm soil conservation. Because of an attribution problem, these additional NRM contributions tend not to be recognized separately as deriving from NRM research, but they are captured in the measurement of economic surplus used in benefit/cost calculations. Similarly, NRM contributions as an input for risk reduction in production, e.g., IPM and adaptation to climatic variability, tend not to be recognized separately. Often they are not even measured by benefit/cost analysis, so that there is an attribution problem as well as an evaluation problem. Further, it is known that NRM contributes as joint product with yield and income effect under the form of positive externalities, e.g., pesticide reduction, pollution reduction, decrease in sedimentation of reservoirs and biodiversity conservation. Yet, these contributions are generally not recognized as due to NRM, and typically are not even measured because the effects are diffuse, and there are no markets for these services. This again points to an attribution as well as a valuation problem. All the above examples of NRM contributions associated with NRM research help explain why low returns are assigned to investments in NRM research.

It is clear from the Cases reported, and many others, that impact assessment as an *ex-post* activity will capture effects some years removed from the time of the interventions. Often it is not even possible to undertake adequate *ex-post* impact assessments of NRM research, because cause-effect relationships are difficult to recognize after a certain time frame, or because of poor baselines or counterfactual constructs, or because the adoption of a component technology has altered productivity but the changes are not picked up in aggregate statistics. Many of the changes in the productivity of goods and services sought by INRM research lend themselves to quantification on a real or near real-time basis, simply because ecosystems' processes work more or less continuously unlike the biological harvest of grain or fish. It is necessary to identify key indicators of productivity and sustainability that can be used to monitor impacts on livelihood parameters, the quality of the biophysical NR components, and ecosystem service processes on an ongoing basis. Integrating such impact monitoring in INRM research is integral to the learning goals promoted by the reported Cases, but it also adds value to *ex-post* impact assessments.

Scaling out and up

Nearly all Cases have highlighted the need for more understanding regarding the issues related to scaling out and scaling up. This is not surprising because the nature of NRM is grounded in the realities of the interactions between the actual resource base, the sociocultural characteristics of the communities, and the infrastructure, institutional, economic, and policy environment at local, intermediate, national and international levels.

For the CGIAR and its partners, the challenge of scaling out and up for INRM must address the question of IPG, because it can be argued that every aggregate situation will be different. However, methods and approaches can be devised that would allow out and up scaling to be managed and promoted by national stakeholders under a diversity of situations. This is a crucial issue that needs to be addressed because progress, as defined by the impact on farmers' well-being, has been far too slow. If IPG models require substantial verification and adaptation before they can be of use in new environments, this may substantially decelerate the whole process of agricultural development. Perhaps other less systematic, iterative and more learning-based experimental approaches that can be managed by farmers and rural communities should also be given more emphasis. This area clearly is linked to the question of individual and collective empowerment and responsibility, as well as impact, and requires expertise in the multidisciplinary teams that goes well beyond the biophysical, biological and economic sciences. There is an increasing role for disciplines such as social anthropology, political science and public administration.

However, the above not withstanding, all the Case studies have focused on important and large ecozones, not just a pilot village or watershed, and have produced methodologies, models, and technologies that could be scaled out to neighbouring areas with more time, if the economy was better or if project funding was greater. Further, it is clear that in each of the Cases there is a realization that policy and institutions are key factors in the scaling up of INRM. It is therefore fitting to conclude that CGIAR's INRM research effort during the recent years, as reflected in the Cases in Part III, has reached a point where the resultant intellectual capital base offers tremendous potential for regional and international impact, particularly under improved economic, institutional and political situations which favour enhanced agricultural and rural development.

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Acronyms

ACUAVALLE	Empresa de Acueductos y Alcantarillados del Valle, Colombia
ADB	Asian Development Bank
AEZ	Agro-ecological Zone
AFE/COHDEFOR	Administración Forestal del Estado, Honduras
AIT	Asian Institute of Technology
AP	Andhra Pradesh
APRLP	Andhra Pradesh Rural Livelihoods Programme
ARC	Agricultural Research Centre, Libya
ARI	Advanced Research Institute
ASB	Alternatives to Slash and Burn
BBF	Broad-bed and Furrow
BIOMA	Biofer Manusia
C&I	Criteria and Indicators
Campos Verdes	Asociación Campos Verdes San Dioniso, Nicaragua
CAP	Community Action Plan
CAPRi	Collective Action and Property Rights
CARE	Comité Americano de Remesas al Exterior, Honduras
CASM	Comisión de Acción Social Menonita - Mennonite Social Action Commission, Honduras
CBD	Convention for Biodiversity
CBO	Community Based Organization
CCD	Comisión Cristiana para el Desarrollo - Christian Commission for Development, Honduras
CDC	Centre Directors Committee
CDP	Community Development Plan
CD-ROM	Compact Disc – Read Only Memory
CEPRODEL	Centro de Promoción del Desarrollo Local, Nicaragua
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro International de Agricultura Tropical
CIEETS	Centro Intereclesial de Estudios Teológicos y Sociales, Nicaragua

CIFOR	Center for International Forestry Research
CIG	Common Interest Group
CIP	Centro Internacional de la Papa
CIPASLA	Consorcio Interinstitucional para una Agricultura Sostenible en Laderas, Colombia
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développment
CIRNMA	Centro de Investigaciones en Recursos Naturales y Medio Ambiente
CLODEST	Comité Local para el Desarrollo Sostenible de la Cuenca del Río Tascalapa, Honduras
CORPOCUENCAS	Corporación Vallecaucana de Cuencas Hidrográficas, Colombia
CORPOICA	Corporación Colombiana de Investigaciones Agropecuarias, Colombia
COSOFAP	Consortium for Scaling Up Options for Increasing Farm Productivity
CP	Challenge Programme
CRIDA	Central Research Institute for Dryland Agriculture
CSAR	Centre for Soil and Agroclimate Research and Development
CSE	Committee on Sustainability and the Environment
DASR	Directorate of Agricultural Scientific Research
DFID	Department for International Development, UK
DICTA	Dirección de Investigación de Ciencias y Tecnología Agrícola, Honduras
DSS	Decision Support System
DST	Decision Support Tool
DWMA	District Water Management Agency
EAC	East African Community
ECOFUTURO	Corporación Socioecológica para el Futuro de Bolívar, Colombia
EMBRAPA	Empresa Brasileira Pesuisa Agropecuaria
ENACAL	Empresa Nacional de Acueductos y Alcantarillados, Nicaragua
ESNACIFOR	Escuela Nacional de Ciencias Forestales, Honduras
EU	European Union
FA	Focal Area

FADC	Focal Area Development Committee
FEPROH	Fomento Evangélico para el Progreso de Honduras, Honduras
FORDA	Forestry Research and Development Agency
FSAP	Farm Specific Action Plan
FSR	Farming Systems Research
GDP	Gross Domestic Production
GIS	Geographic Information System
GPS	Global Positioning System
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HNPV	Helicoverpa Nuclear Polyhedrosis Virus
IARC	International Agricultural Research Centres
IBSRAM	International Board for Soil Research Centre
ICARDA	International Centre for Agricultural Research in the Dry Areas
ICRAF	International Centre for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technology
IDRC	International Development Research Centre, Canada
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGNRM	Integrated Genetic and Natural Resources Management
IHCAFE	Instituto Hondureño del Café, Honduras
INIA-PISA	Instituto Nacional de Investigacion Agropecuaria – Proyecto de Investigacion de Sistemas Agropecuarios Andinos
INRA	Institut National de la Recherche Agronomique, Centre Aridoculture, Morocco
INRAT	Institut National de la Recherche Agronomique de Tunisie
INRM	Integrated Natural Resources Management
INTA	Instituto Nacional de Tecnología Agropecuaria, Nicaragua
IPA	Agricultural Research Centre, Iraq
IPG	International Public Good
IPGRI	International Plan Genetic Resources Institute
IPM	Integrated Pest Management

IRD	Institute of Research for Development
IRD	Institut de Recherche pour le Développement
IRR	Internal Rate of Return
iSC	CGIAR interim Science Council
ISNAR	International Service for National Agricultural Research
ITGC	Institute Technique des Grandes Cultures, Algeria
ITTO	International Tropical Timber Organization
IWM	Integrated Watershed Management
IWMI	International Water Management Institute
KACE	Kenya Agricultural Commodity Exchange
LARI	Lebanese Agricultural Research Institute
LE	Larval Equivalent
M&M	Mashreq/Maghreb
MDCL	Minimum Diameter Cutting Limit
MOU	Memorandum of Agreement
MSEC	Management of Soil Erosion Consortium
MVF	M. Venkatarangiaya Foundation
NAFRI	National Agricultural and Forestry Research Institute
NALEP	National Agriculture and Livestock Extension Programme
NAP	Negotiated Action Plan
NARC	Nepal Agricultural Research Council
NARD	National Agriculture Research and Development
NARES	National Agricultural Research and Extension System
NARS	National Agricultural Research System
NCARTT	National Centre for Agricultural Research and Technolgy Transfer, Jordan
NEMA	National Environmental Management Agency
NGO	Non-Governmental Organization
NISF	National Institute for Soils and Fertilizers
NR	Natural Resources
NRM	Natural Resources Management
NRSA	National Remote Sensing Agency

NTU	Normalized Turbidity Units
NVS	Natural Vegetation Strip
PAR	Participatory Action Research
PCARES	Predicting Catchment Runoff and Soil Erosion for Sustainability
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PLER	Predict and Localizr Erosion and Runoff
PM&E	Participatory Monitoring and Evaluation
PRA	Participatory Rural Appraisal
PRODERCO	Proyecto de Desarrollo Región Centro Oriente, Honduras
PRONADERS	Programa Nacional de Desarrollo Rural Sostenible, Honduras
READ	Rural Education and Agricultural Development
RFD	Royal Forest Department
RIL	Reduced Impact Logging
RRA	Rapid Rural Appraisal
SAT	Semi-arid Tropics
SDC	Swiss Development Cooperation
SEAMEO	Southeast Asian Ministers of Education Organization
SEARCA	SEAMEO Regional Centre for Graduate Study and Research in Agriculture
SHG	Self-help Group
SSLCC	Soil Survey and Land Classification Centre
SWNM	Soil Water Nutrient Management
SWP	Systemwide Programme
TAC	Technical Advisory Committee to the CGIAR
TFF	Tropical Forest Foundation
TIPO	Technological, Institutional and Policy Options
TROPISEC	Programa del Trópico Seco, Nicaragua
TSBF	Tropical Soil Biology and Fertility
UCA	Universidad Centroamericana, Nicaragua
UCOSD	Unión de Campesinos Organizados de San Dionisio, Nicaragua
UG	User Group

UNA	Universidad Nacional Agraria de Honduras, Honduras
UNA	Universidad Nacional Agraria, Nicaragua
UNA-Atlántida	Universidad Autónoma Nacional de Honduras – Atlántida
UNAN	Universidad Nacional Autonoma de Nicaragua
USAID	United States Agency for International Development
WANA	West Asia and North Africa
WV	Visión Mundial, Honduras
WV	World Vision, Nicaragua
WWF	World Wildlife Foundation

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